The Dock and Harbour Authority

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Editorial Comments

Canton.

There is a decided and refreshing element of novelty and interest in turning from a consideration of modern ports, Corpus Christi for example, established in virgin locations with all the advantages and transport, to those, the foundations of which go back through the centuries to the early days of civilisation. Such a port is Canton, or more correctly though less familiarly Kwangchou, in South China, which is the subject of this month's leading article. After reading about the modern and efficient lay-out of some young ports on the American seaboard, our readers may find it an agreeable change to investigate the conditions under which an ancient Chinese port came into existence and to trace its development amid the vicissitudes of its history.

Not only is the distinction one of time: it is also one of tradition and environment, for Chinese culture differs fundamentally from that in the Western Hemisphere and the influences at work have been materially divergent. Dr. Chatley, who has spent many years engaged in port and harbour work within the Celestial Empire and is well acquainted with the temperament and characteristics of its inhabitants, gives in his article an interesting and instructive exposition of the development of port enterprise on Oriental lines. One feature of the situation stands out in clear prominence, viz., the predominating factor of cheap labour. The immense resources of man power and the low standard of living in China have combined to remove one of the main incentives to the introduction of mechanical labour-aiding appliances which have become essential to the economic conditions in Europe and America. Moreover, the displacement of manual labour by machinery has, at the outset at any rate, the unfortunate effect of putting great numbers of men out of employment, depriving them of their sole means of gaining a livelihood and throwing them on to an already overloaded labour market. In the course of modern progress, the situation adjusts itself and openings are eventually found for unskilled, as well as skilled, labour in conjunction with machines, but the process takes time and meanwhile large sections of the population, already reduced very nearly to limits of privation, would be left starving. Hence their reluctance to acquiesce in the desirability for change.

It will be well within our readers' knowledge that the progress of hostilities between Japan and China has recently brought the military forces of the former country into Southern China and that operations in and around Canton have caused grave concern for the safety of the British colony of Hong-Kong, which is less than a hundred miles away. The menace is still existent, and this fact adds a degree of propriety to a consideration of the port of Canton, its present accommodation and shipping facilities and its future capabilities.

The Proposed Forth and Clyde Canal.

Enthusiastic advocates for a ship canal to connect the East and West Coasts of Scotland through the narrow Isthmus between the Firths of Forth and Clyde would not derive much satisfaction from the ministerial answer recently given to a question on the subject in the House of Commons. Asked whether, arising out of the experience of the war, the Government would consider making preparations for the enlarging of the present Forth and Clyde barge canal, or the construction of a new Mid-Scotland canal for ocean-going ships, the Parliamentary Secretary to the Ministry of War Transport replied that since the issue of the report of the Commission of 1937, stating that the advantages to be gained were insufficient to justify the construction of a ship canal, nothing had transpired to warrant a reversal of the verdict. In reply to a supplementary question, Colonel Llewellin added that the work would take so long and employ so much labour that it was not a matter that could be undertaken in the middle of a war.

This is undoubtedly true and scarcely any other answer could be expected. The unfortunate aspect of the affair is that the Canal, in view of the military and naval importance of a short navigable cut between the Forth and the Clyde, ought to have been constructed years ago. Located in the Forth is the great naval base of Rosyth, only accessible to shipping from the East, so that if anything happened to block the Firth, such as the collapse of the Forth Bridge under a bombing attack, the dockyard would be put out of action, or at any rate, have its utility seriously curtailed. Apart from this contingency, which is by no means so fanciful as might appear at first sight, the convenience of water inter-communication between the two Firths would be appreciable. The Clyde is a great ship-building and ship-repairing centre, and assuming continued immunity from interruption of the Firth of Forth, there would be considerable economy in time and cost to mercantile shipping if a sheltered and relatively safe waterway enabled vessels to pass from the East to the West Coast otherwise than by a lengthy, circuitous route.

However, the hard fact is that construction of such a waterway is for the time being out of the question. It could not be completed for use in the present war, even if, as Colonel Llewellin could not do otherwise than deny, the labour, and indeed the plant, were available. The cost has been put at fifty millions or more, though since this country has become so accustomed to "astronomical" figures of expenditure, perhaps this consideration does not carry much weight, especially when the safety of the community is concerned.

We have discussed the projected undertaking in an earlier issue (May, 1939), in a Comment in which particulars were given of the existing barge canal and of the proposed ship canal. Briefly stated, the most suitable route for the new waterway would have a length of about 30 miles from the River Forth at Grangemouth to the Eastern end of Loch Lomond, whence a cutting, 5 miles in length, would connect with the River Clyde at Dumbarton. The total length of 35 miles compares favourably with the 50 miles of the Panama Canal and the 61 miles of the Kiel Canal.

Perhaps when the present conflict is over, the country will have acquired wider horizons of political and commercial vision and will be less disposed to fight shy of the expenditure of fifty millions on a work of national importance.

Inland Sorting Depôts.

Not the least striking and important of the recommendations made in the Sixteenth Report of the Select Committee on National Expenditure, recently issued and reproduced in an abridged form in our last issue, was No. 5, relating to port working, which reads as follows: "That Inland Sorting Depôts should be provided without loss of time." At first sight, this recommendation seems very much on the same lines as a suggestion put forward in a London evening journal a few months back by an unnamed stevedore "with unique experience in discharging ships in the last war." The suggestion was "to build transit sheds far away in the country" in order to avoid the delay and inconvenience to shipping resulting from protracted occupation of the quay frontage by cargo deposited thereon. The system, it was stated, had been tried and found to work satisfactorily in France during the last war.

In our Comment on the proposal (*vide* the April issue) we commended the suggestion for consideration, though finding it

Editorial Comments—*continued*

necessary to point out that it might not be altogether easy of realisation at many British ports on account of the populous areas in which most of them are located and the consequent impediment to the expeditious movement of traffic along routes leading to the open country, rarely conforming to the ideal that " they should run straight out for fast traffic, like the spokes of a giant wheel, its hub being the port."

Further consideration raises the doubt as to whether this (or something like it) is what the Committee had in mind. At any rate, there is a little uncertainty as what they mean precisely by the use of the term " Inland Sorting Depôts," and it is not removed by consultation of the volume on " Transportation at the Western Front," by Colonel A. M. Henniker, in the Official History of the War, to which reference is made by a footnote in the Report. The problem in France, during the occupation of certain French ports by the British Expeditionary Force, apparently concerned the use of sheds as temporary storage depôts and not as what are technically called Transit Sheds, that is to say, sheds set apart for the process of sorting goods to marks.

In Colonel Henniker's book, it is related that the hangars (the French term for quayside, as well as other, sheds) were used for the reception of stores until " the hangars became full and stores overflowed on to the quays " (p. 181), which, in turn, became overcrowded. Shipping delays resulted and " the congestion was ascribed mainly to the use of the transit sheds as *depôts* " (p. 182: the italics are ours). A solution of the problem was eventually found in " the general policy of using the ports for transit alone, and, as far as the conditions which had grown up would allow, of transferring the depôts to new sites outside " (p. 229). Clearly then, the depôts must have been more of the nature of warehouses than of sorting sheds, though they may have been used for both purposes.

It certainly seems desirable that a fuller explanation should be given of what is meant by " inland sorting depôts," since the analogy of these with the depôts used in France is apparently not complete. Let us briefly analyse the conditions in some detail, taking them as they are to be found in peace time. The war will necessarily have introduced certain modifications, but scarcely, we should imagine, to any fundamental extent.

It need hardly be pointed out to readers of this Journal that the handling at the quayside of cargo of a miscellaneous character is a very complex process. The numerous individual consignments have to be picked out at the ship's rail by gangs of men and trucked to particular locations for collection and despatch. Goods, however, cannot be stowed at the port of origin in the precise order required for convenient allocation. Questions of trim and stability, as well as the economic use of shipping space, have to be taken into account by the loading stevedores. Moreover, a ship may call at various ports in the course of its voyage for further consignments, which necessarily will overlie the earlier shipments and come out in that order.

Although the enormous mass of parcels of diverse kinds and sizes, constituting a ship's freight, can, if desired, be discharged pell-mell from the holds at it comes, and, theoretically at least, be transported elsewhere for sorting to the hundreds of marks of which it is composed, the speedy removal for allocation at a distance of such a conglomeration of commodities presents difficulties of no mean order, with the added complication that all goods are not immediately landward bound, but that, at certain ports, notably London, a very large percentage of the goods is required to be delivered overside into barges and lighters for transport by water.

Under untrammelled conditions, an ideal arrangement might conceivably be found in the example of Trafford Park at Manchester, though this is actually designed primarily for warehousing. Were, however, such an area available within easy distance of the quayside and served by a rapid shuttle rail service, it might be practicable to deal with cargoes in the manner suggested, especially if there were a canal frontage for re-deliveries to barge. But this arrangement would not suit, nor indeed be practicable, at every port.

It must be confessed that the proposal to build inland sorting depôts (if by this is meant sheds for sorting purposes) though attractive, is beset with problems, the solution of which to meet local conditions at British ports may not readily be found. Moreover, such depôts would lose much of their utility as transit sheds at the conclusion of hostilities, though this point may not count for much at a time when national exigencies, however transient, are paramount and is offset by the consideration that other uses could probably be found for the structures.

Pilferage at Ports.

The Annual Report of the Committee of the London General Shipowners' Society, amongst other matters, calls attention to a serious increase in pilferage and petty thefts from vessels loading and unloading at ports. In doing so, it is adding point to representations already made by the Select Committee on National Expenditure, who devoted a section of their recent report to a consideration of the evil and its treatment. In both documents, the view is taken that the penalties imposed by the magistrates, in cases in which convictions are secured, are inadequate, and that sterner disciplinary measures are required to act as a deterrent. The Select Committee go so far as to say that it may become necessary to treat offenders with the same severity as those convicted of looting in war-time.

Certainly there has been a plethora of evidence in the press lately of the widespread prevalence of this form of dishonesty. Speaking at Bristol, the chairman of the magistrates is reported as saying, " our docks appear to be infested with thieves." At Liverpool, there has been a large number of cases in which dock labourers have been sentenced to terms of imprisonment with hard labour, and the same can be said of other ports.

How to eradicate the evil is a difficult problem. In the aggregate, the losses, mostly borne by the insurance companies, must be enormous, running annually into millions of pounds. It is understood that the matter is under consideration by the Dock and Harbour Authorities' Association. It certainly should receive, as the Select Committee recommends, the attention of the Government Departments concerned and the Ministry of War Transport is urged to consider seriously " the advisability of depriving—either temporarily or permanently—the convicted offender of his place on the register and therewith of his right to employment as a dock labourer."

Mr. J. Gibson Jarvie, Regional Port Director of the North Western Area has appropriately pointed out in a timely public statement on the subject: " Dockers are just as much in a position of trust as bank clerks or shop assistants; they are handling valuable cargoes belonging to other people and shippers and shipowners must be able to trust them. The country is engaged in a life and death struggle and has a right to expect the fullest effort " (and, we are entitled to add, the highest integrity) " from the dockers in loading and unloading ships." The great majority no doubt respond to this standard; it is the relative few who bring a reproach upon their calling.

Cretan Ports.

Although now submerged in the unhappy past, it is perhaps permissible to make a tardy allusion to the tragic, but heroically memorable, epic of the struggle of the British and Anzac forces, together with their Greek allies, for the retention of possession of Crete, since it allows attention to be directed to a remarkable island which was the cradle of Mediterranean civilisation, and to its ports, three, at least, of which have become familiar through mention in the news.

As regards the island itself, it can be described very roughly as an elongated rectangle, some 160 miles in length along its East to West axis, with an irregular breadth varying between extremes of 35 and 10 or 12 miles. By far the greater part of the surface is mountainous, and the central peak, Mount Ida (not, by the way, the " many fountain'd Ida," of Tennyson's poem, *Oenone*, which is in Troas in Asia Minor) rises to a height of over 8,000-ft. The northern coastline is broken and varied, with a number of rugged promontories jutting towards the Aegean Sea, notable among them being the hilly peninsula called Akotiri, which bounds Suda Bay on its western side, where there is ample and safe anchorage for a large-sized fleet. The South Coast is less indented and contains few good harbours, the mountain sides rising precipitously from the sea. There is, however, one well-sheltered bay, about 5 miles East of Cape Litino, identified as the " Fair Havens " mentioned in the Scriptural record of the Journey of St. Paul to Italy (Acts xxviii. v. 8).

The Cretans are naturally a seafaring race and appear as such in the Homeric poems. Located almost midway between Europe, Asia and Africa, their country has long been a natural calling place for navigators traversing the Eastern Mediterranean. In modern times, seaborne traffic has been centred at the ports of Canea (the capital), Candia or Heraklion, and Retimo or Rethymo. Canea has a small harbour with a depth of 15-ft. at the entrance and 12-ft. inside. Loading and discharge is mainly done by means of lighters. The harbour at Candia includes a new section " affording good shelter and cargo handling facilities." Rethymo has an entrance depth of 12-ft., and only vessels of 500 tons or less can enter the port. Vessels of greater tonnage have to load and discharge in the outer roadstead, which is reputed to be dangerous in winter on account of northerly gales.

Such are the physical and commercial features of an island, the loss of which to the British and Greek forces is greatly to be deplored from a military point of view.

The South African Graving Dock.

According to the latest South African press reports to hand, Cape Town is to have its much desired up-to-date graving dock at some unspecified date in the future. The Minister of Railways and Harbours has given an assurance to this effect to a deputation, representing the Cape Town Chamber of Commerce, the City Council, the Chamber of Industries and other local interested bodies, which waited upon him early in May. He acknowledged the desirability of constructing a new graving dock and stated that steps were being taken to obtain preliminary data as to size and estimated cost.

The City and Port of Canton

The Port of Canton

An Ancient World Harbour

By HERBERT CHATLEY, D.Sc. (Eng.), M.Inst.C.E.

General and Historical

CANTON (properly called Kwangchou, Canton being actually the name of the province, Kwangtung, of which it is the capital) has existed as a city for at least two thousand years. Prior to the second century before the Christian era this part of modern China was not Chinese but was occupied by aborigines partially affected by the spread of Chinese culture from the north. The Han dynasty then extended its power south of the Yangtze catchment area into this region

Although not now a first-class port, the city of Canton is in an historic sense the most important port in China. In the first place, prior to the coming of European ideas, it was almost the only Chinese port in relatively free sea communication with other lands. China is separated from Burma and India by a series of enormous mountain ranges, malarial valleys and rapid rivers which were almost impassable, and these all lead up to the very high Tibetan plateau which is even now a most formidable obstacle to communication. The land communications of old (i.e., north) China across Turkestan with India, Persia and Bactria (Afghanistan) were moderately well developed from the first to the fourteenth century, but after the collapse of the Mongol Empire they were practically broken off. These routes were in any case extremely long, hazardous and difficult, liable to military interruption, and were quite unsuited for transport (generally by camels) for anything but compact valuable material such as silk, tea, jade, silver, etc. The renaissance of Greek learning in Baghdad under the Khalifate in the ninth century led to much increased ocean navigation, the use of the mariner's compass and rather long voyages. Indian and Arabic contacts with Canton go back to this time, and the Chinese annals of the contemporaneous T'ang dynasty indicate a considerable amount of sea travel between China and the East Indies. Marco Polo, writing at the end of the thirteenth century, appears to refer to Canton as "Kangiu" and says:—

"Through the midst of it passes a river, a mile in breadth, upon the banks of which, on either side, are extensive and handsome buildings. In front of these, great numbers of ships are seen lying, having merchandise on board, and especially sugar, of which large quantities are manufactured here also. Many vessels arrive at this port from India, freighted by merchants who bring with them rich assortments of jewels and pearls, upon the sale of which they obtain a considerable profit." (Book II, Chapter LXXXVI.)

Marco Polo himself returned to the Persian Gulf from a nearby port ("Zaitun") by sea, thus showing the lengths of voyage which were possible. At this time practically the whole of Asia was controlled by the Mongols and this political unity helped communications.

The Portuguese first visited Canton in 1516, the Dutch about 1620, and the English in 1637, shortly before the Manchus conquered China. The East India Company established a "factory" in Canton in 1684 and, owing to the exclusion policy of the Manchus, it was the only port in which the Chinese would permit foreigners to trade until 1841.

Thus Canton until a hundred years ago was the principal focus of sea trade and foreign influence in China. The subsequent growth of Shanghai, Hankow and Tientsin deprived it of its predominance in this respect, but it still remains a very important centre, although overshadowed as a port by Hongkong, which has supplanted it as the local transhipment point for deep draught ships. The island of Hongkong is about 90 miles (by air) from Canton and was ceded to Great Britain in 1841 as the result of the war with China which arose from the intolerable conditions of the Manchu policy. Contrary to popular belief, the war had little to do with opium, but was due to the Chinese desire to treat Britain as a vassal power. The peninsula of Kowloon was added to Hongkong in 1861 and an additional area of territory subsequently leased. This place has grown from a mere fishing centre to a world port of great importance, owing to the excellent facilities for the accommodation of large ships. (See *The Dock and Harbour Authority:* May, 1926, and December, 1936. The largest ships plying upon the Pacific can berth there and, being a free port, it serves as a general entrepôt for the trade of the West Pacific and also as a depôt for the trade of Canton, which last place is, speaking broadly, now only visited by coasting vessels.

Communications

Apart from the very complex network of canals and rivers in the neighbourhood of Canton, which give access to all parts of the alluvial plain, Canton has long been connected by canal with central China via the North River. As, however, there are rapids and portages to be passed, this route has not been an economical one, and since the coming of steam shipping it is cheaper to bring cargo from, say, Hankow, by way of the Yangtze River and the coast than to transport it overland. The mountain range which separates the catchment areas of the Kwangtung province from that of the Yangtze River has also formed a serious political obstacle. After many years of discussion and projects, a railway was eventually carried through to Hankow and was operating shortly before the present hostilities. There can be little doubt

Port of Canton—continued

that this line will play a great part in the future of Canton, although here again the question of Hongkong arises, since it is cheaper to operate cargo direct to that harbour (at Kowloon) than to load it at Canton city. Part of the railway has been working for many years prior to the through connection, and this has been an important feeder. Dirt roads for robust motor traffic have been built in recent years, but on the minor tracks

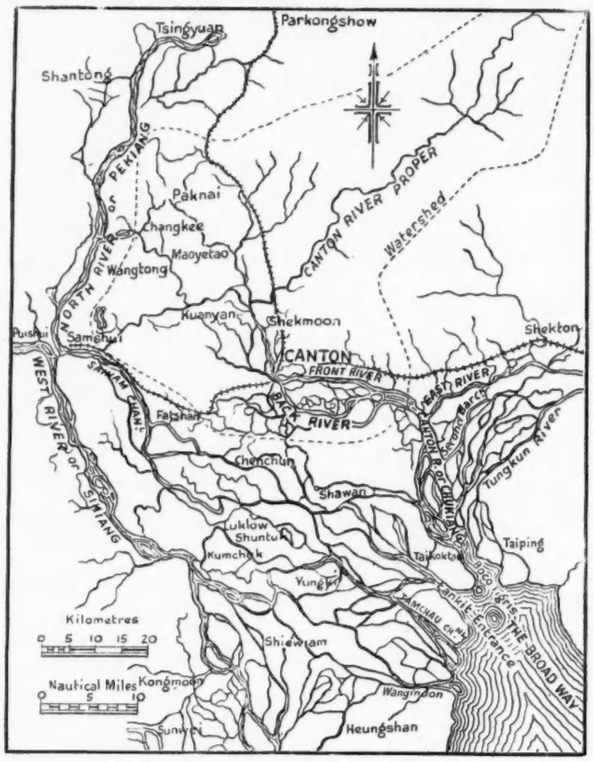


Fig. 1. Map of Canton River and Delta.

wheelbarrows are still used where boat connections are not possible. Aerial services from Canton to other centres in China were operating before the hostilities broke out.

Climate

Canton is a very humid place and therefore somewhat unhealthy. The mean annual rainfall is 1,540 millimetres (about 60 inches), the maximum and minimum annual records being 2,035 and 1,115 millimetres. The summer is the wettest period, July having a mean value of 242 millimetres, while December's is only 40 millimetres. Fifty per cent. of the year's rainfall occurs in June, July and August. The maximum recorded rainfall in 24 hours is 166 millimetres, but as high as 20 inches fell in 8 hours in Hongkong on the 18th July, 1926, so that this figure cannot be by any means the worst that can occur in Canton, in spite of the fact that the intensity falls away rapidly as the moist air passes inland.

The prevalent direction of the wind is north-east in January and south in July, following the usual monsoon regime in south-eastern Asia. Very severe typhoons may occur from June to September, one or two approaching quite close each year. When, as is often the case, these are accompanied by heavy rain, the wind pressure may reach as high as 100 pounds per square foot of an exposed surface, owing to the heavy moisture content of the air, which increases its mass at least 100 per cent.

Temperature is more constant in the more northerly parts of China. The mean value is 72° F.; the range of the monthly means from summer to winter is 24° F., the mean value for July being 82° and the mean value for February 58°. The absolute recorded maximum is 101° F. and the minimum 35°, but these extremes are unusual. Although Canton is close to the Tropic of Cancer, the radiation of the sun is screened by the high vapour content of the air, so that the temperature is not so high as occurs in North China in the summer. This does not mean that it is any more comfortable, since the humidity checks perspiration and great effort is exhausting. In spite of this condition the people of Canton are extremely active and enterprising, although physically inferior to the northern Chinese.

Tides

The spring range at the Whampoa Anchorage, which is the highest point in the Canton approach reached by moderately large vessels, is about 8 feet. (Fig. 2). At Canton city this is reduced to about 6½ feet. Neap tides are rather feeble, the range only being about one foot. The tidal current in the main channel between Whampoa and the City (The "Black Reach") attains a speed of about 1½ knots, depending on the tide and the upland run-off.

Trade

As in all Chinese ports, the trade statistics are complicated by the large variations in the exchange value of the currency, so that apparent changes are not necessarily indicative of corresponding changes in volume. Early in the history of the official records since the opening of the port to foreign trade the total (imports and exports) was of the order of two hundred million Chinese dollars. Just before the War of 1914 the total was about 170 million dollars (say, £10 millions), roughly divided as follows:—

Net Foreign Imports, c.i.f.	...	47	millions of dollars
Net Chinese Imports from other Chinese ports, c.i.f.	... ...	30	do. do.
Exports to Foreign ports, f.o.b.	...	91	do. do.

showing a so-called favourable balance (i.e., an excess of sales) of 14 millions of dollars. These were largely paid for by the remittances of the millions of Chinese living in the East Indies and Malaya. In recent years there has been a considerable decline. In 1936, the last year for which satisfactory figures are available, the imports (Chinese and foreign) amounted to 31 millions and the exports to 42 millions of dollars. The sterling value of the dollar was lower in 1936 than in the period before the war of 1914 and prices were higher, so that this represents a definite decrease of volume of goods. Remittances from Chinese abroad have decreased and there have been appreciable changes in flow, due to attempts at autarchy, boycotts, civil war, etc.

The imports from foreign countries are cotton yarn, kerosene, gasolene, flour, shirtings, rice, coal, paper, fish, printed cottons, medicines, scrap iron, machinery, motor cars, bicycles, etc. It must be remembered that "foreign" here includes the East Indies, Tongking, Siam, Malaya, the Philippines, etc. The imports from other Chinese ports include beans, bean oil, oil cake, peanuts, rice, etc. The exports to foreign countries include raw silk, silk fabrics, wood oil, bamboos, mattings, tea, ginger, cassia bark, porcelain, fans, crackers, furniture, semi-precious stones, marble, ivories, paper, antimony, wolfram, etc. Here again it must be remarked that many of these things are for the use and convenience of Chinese living outside of China, whose associations with Canton are strong. The fact that rice is often imported is significant, showing that the intense population often exceeds in consumption its own production of the staple food of the southern Chinese.

Population

The population of Canton city is over one million, and of this number some 150,000 live in boats on the adjacent waterways. The delta plain is quite densely populated, so that the population with close relation to Canton numbers several millions.

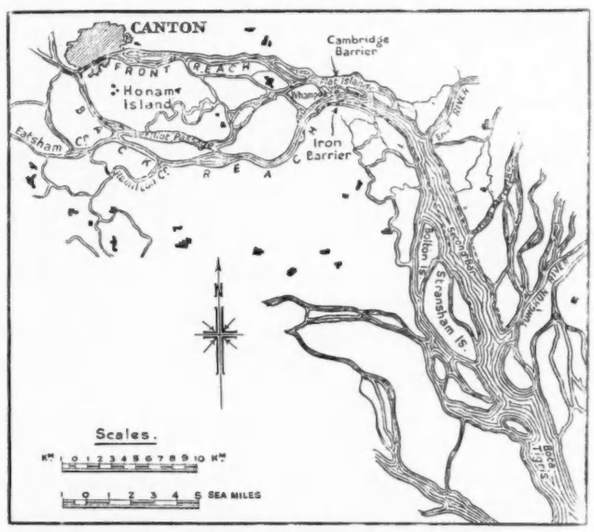


Fig. 2. Map of the Approaches to Canton.

Shipping

The port of Canton shows a bewildering variety of vessels. Steamers up to 19 feet draught have reached Canton City, but about 12 feet is the usual limit. Whampoa can be occasionally reached by a 24 feet draught vessel, but the usual limit is about 18 feet. Steam launches up to 400 tons abound, Junks up to about 300 tons deadweight are still used to some extent, and small sailing and rowing vessels abound.

Port of Canton—continued

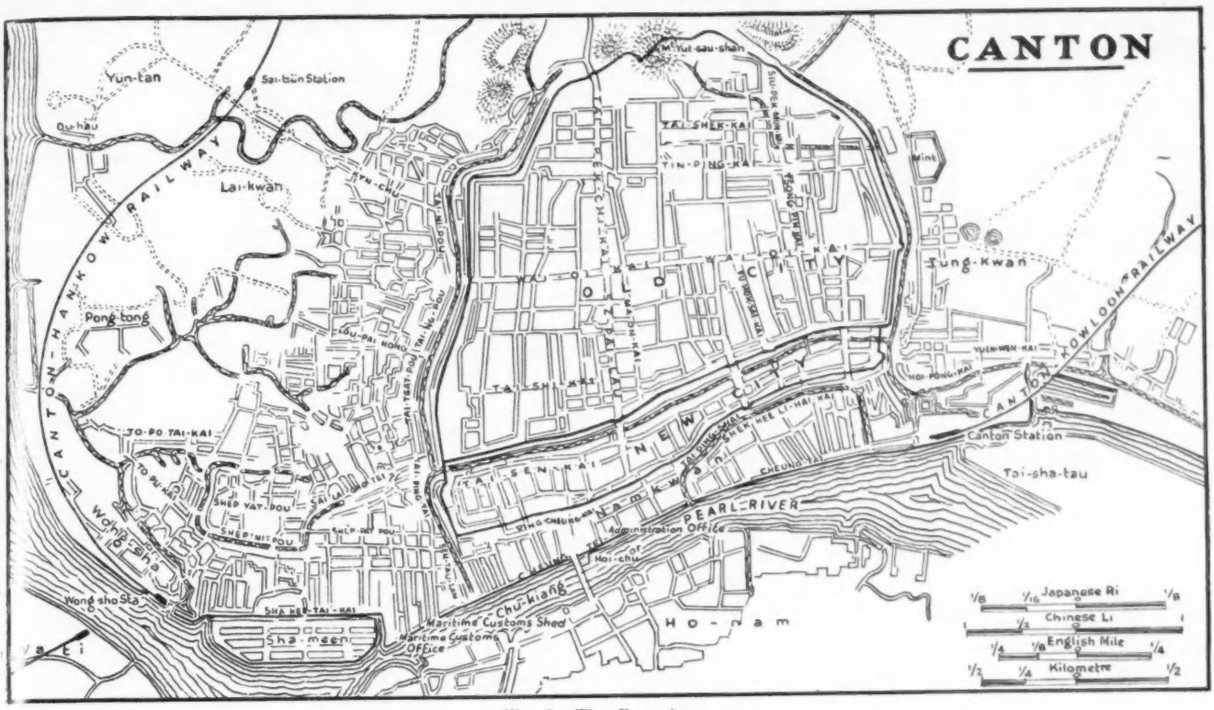
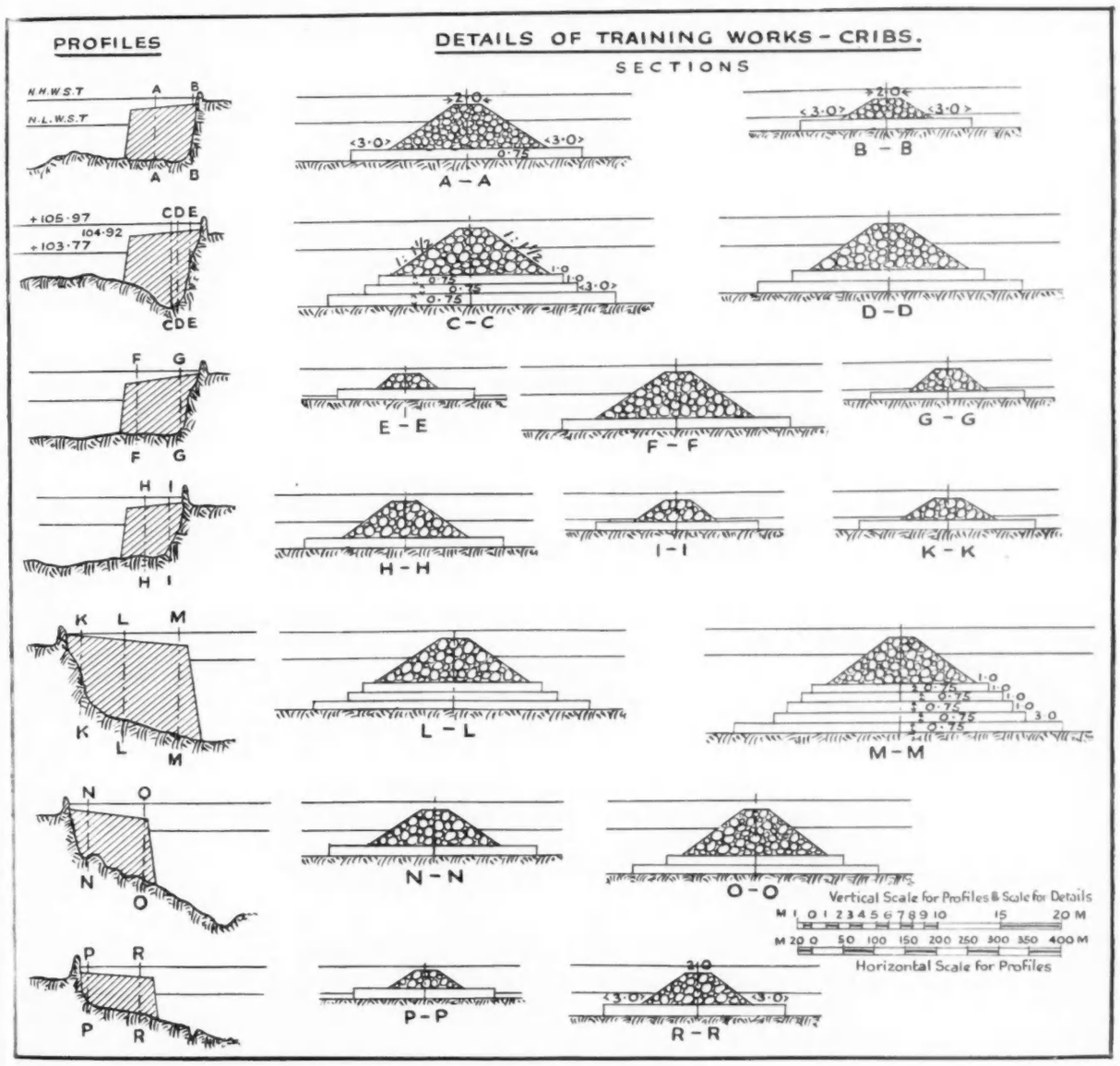


Fig. 3. The Port Area.



Approaches to Canton Harbour

Port of Canton—continued

The annual entries of all kinds of vessels, other than those plying in the harbour, certainly exceed ten million net registered tons.

Topography (Figs. 1 and 2).

Canton is situated south-west of a range of hills near the head of a very large and intensely cultivated delta formed at the confluence of the West, North and East Rivers of the Kwangtung province. It is, however, not actually on any of these three rivers, but on a much smaller stream (catchment area of about 1,800 square statute miles), called the Chu Kiang or "Pearl River." Below Canton this is entered by the East River (more correctly it is a tributary of that river), and has thence a large tidal entrance which emerges on to a gulf of the sea at Hu Kou (The Tiger's Mouth or Bocca Tigris), some 30 sea miles north-west of Hongkong. Macao, an old Portuguese settlement, lies on the west shore of this gulf.

The Chu Kiang runs on the south side of Canton City in two arms, termed the Front and Back reaches, between which there

Shameen Canal, from English Bridge

are several islands. At the west end of this split is the suburb of Honam ("South of the River"), connected to the City by a bridge. The Front Reach, on whose left bank the City is situated, is not available for river steamers except at high water. The Back Reach is the regular approach and is only 10 feet deep at low water at certain places.

These two arms reunite at Whampoa, some 12 sea miles to the east of the city.

The delta is intersected by myriads of streams, many of which are tidal, and the internal water communications for small craft are therefore excellent.

A small Franco-British settlement exists at Canton on a reclaimed sand bank, called Sha-mien, just off the south-west part of the City. The Harbour is just a simple river channel, with no accommodation except buoys and wharfside quays, and few serious works of improvement have been undertaken. Since the coming into power of the Republican regime and the Nationalist Party, the City itself has been greatly improved. The main streets were formerly very narrow, stone-flagged alleyways, only suited for sedan chairs, but these have been straightened and widened into motor roads, a broad bund road has been made on the bank of the Front Reach, and a bridge thrown across to Honam. There has, however, been considerable damage done by aerial bombardment during the recent fighting.

Conservancy Measures

In the year 1914, at the request of the Chinese Government, Canton was visited by Col. von. Heidenstam (Swedish), then Engineer-in-Chief to the Whangpoo Conservancy Board (Shanghai harbour) to advise as to flood control on the West River. As a result of his recommendations a Board of Conservancy Works of Kwangtung was formed and a Chief Engineer, Major G. W. Olivecrona, was appointed. Under his direction a very considerable amount of river training work (embankments, sluices, etc.), was done in the alluvial plain. In 1915, on a second visit, Col. von Heidenstam was asked to report on the improvement of the approaches to Canton, which he did. In 1917 Major Olivecrona submitted a project of dredging and training in the channel between Whampoa and Canton City, but this has never been carried out. The estimated cost was nearly Three Millions of Hongkong dollars (about £300,000 at that time). After the Nationalist party came into power about 1927 considerable interest was shown by them in the idea, and about 1935 further projects were drawn up, more or less on the lines indicated previously, but with special emphasis on the use of Whampoa for larger ships.

The Whampoa Harbour Question

Ever since Hongkong began to overshadow Canton there has been a question of providing an ocean port at Whampoa (not, by the way, to be confused with the Whangpoo River at Shanghai), which would serve deep draught shipping.

The sea approach to Whampoa from the open water west of Hongkong crosses a shallow area ("The First Bar") with about 21 feet low water depth before entering the Bocca Tigris, where the depth in the main channel exceeds 35 feet. A depth of 24 feet then exists for about eleven miles, when the so-called "Second Bar" is reached with only 17 feet. (See Fig. 2). A further ten miles with greater depth brings one to the Whampoa Anchorage with 24 feet low water depth over a fairly large area. From thence the Back Reach leads rather tortuously to Canton City, the ruling low water depth therein being about 10 feet. Between the Front and Back Reaches there are several islands at Whampoa with rather difficult passages between.

As already mentioned, at spring tides 24-feet vessels can reach Whampoa and a 19-feet draught vessel has reached Canton under unusual conditions.

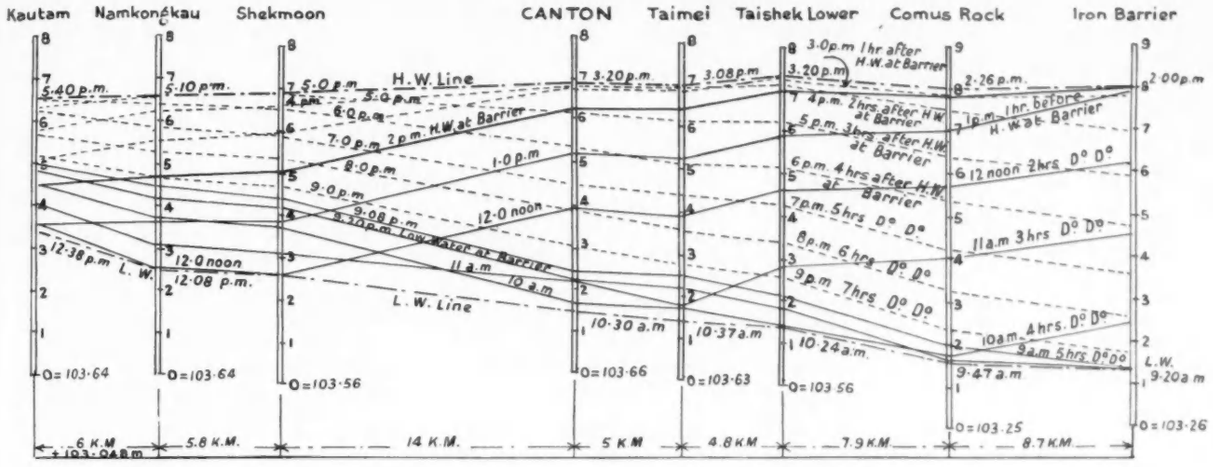
In view of the great cost of tackling the First and Second Bars which thus remain the criteria of admissible draught, Major Olivecrona felt himself unable to recommend more than the regulation of a five metre (16 feet) channel from the Whampoa Anchorage to the City, but the Chinese authorities have never been satisfied with this limited idea, and, in fact, nothing has been done to realise it.

In 1919 Dr. Sun Yat-sen (a native of the province), the subsequently apotheosized Party Leader, in his "International Development of China," proposed making Canton the "Great Southern Port" of China, and sketched out a very ambitious scheme of development of which the central feature was the deepening of an ocean passage, 24 feet at low water, from the sea to Whampoa Anchorage, and large canals to the North and East Rivers. The Nationalist Party was much in favour of this scheme, and in 1937, a few months before hostilities with Japan commenced, a beginning had been made with the construction of a modern type of wharf at Whampoa, and some dredging, with a dredger barrow from the Whangpoo Conservancy Board, Shanghai, had been commenced. It is to be feared that the magnitude of the undertaking had not been fully realised, but, however that may be, the work was stopped by the fighting, and its future is uncertain.

Existing Equipment

Broadly speaking, there is no special accommodation for steamers in Canton harbour, and they simply berth at buoys or alongside simple pontoon quays. All handling of cargo is done by hand labour or with the ship's own cranes. Owing to the low standard of living and the immense population this is cheaper than mechanical working for all operations except the manipulation of very large weights or of bulk cargo, such as coal or grain. Even in speed it compares as far as the clearing or loading of a ship is concerned, but the same cannot, of course, be said of the shore operations. The problems of unemployment

Port of Canton—continued



Profiles of Water Surface at one hour intervals before and after High Water at Iron Barrier and the High and Low Water Lines Spring Tides, 18th September, 1917.

which arise temporarily when manual labour is replaced by mechanical devices are particularly serious in China, owing to the numbers of men involved and their local associations.

The buoyage, lighting, weather signals, berthing, registration, etc., are in the hands of the Chinese Maritime Customs, which also interests itself in minor conservancy matters such as the positions of jetties There has been an unfortunate tendency for the municipal authorities, without any technical experience, to interfere with such affairs, sometimes with rather unhappy results, but prior to the present outbreak of war, liaison had somewhat improved.

Future Conditions

At the present juncture, prophecy is rather futile, but there can be no doubt that sooner or later Canton will recover its importance as a provincial centre. Whether it can become a world port is doubtful since there are other places near by with better sea approaches and better harbour accommodation. In spite of the truth of the principle that shipping should be taken inland as far as possible, the economical limits set by the cost of improvement and maintenance of the channels are rather adverse to it (or, rather, Whampoa) reaching a first-class position.

Legal Notes

Recent Decisions of the Courts

1. Trespassing in Search of Dunnage

A case of interest to stevedores and others engaged in cargo handling operations was decided at Britsoi Assizes on the 3rd and 4th of July when Mr. Justice Charles tried an action in which Fredk. Belville, who fell 24-ft. down a hold on board a Greek vessel which was being discharged at Avonmouth in October, 1939, made a claim for damages for personal injuries on the ground of breach of statutory duties.

Plaintiff was an employee of John Robinson & Co., Ltd., who were receiving a cargo from deck level, and defendants were C. J. King & Son, Ltd., who were handling the cargo up on to the deck. Against a claim that the hatch was not properly fenced or covered, defendants said that the hatch was in use for the passage of goods; alternatively, that there was only a short interruption of work. It was also alleged that the plaintiff was a trespasser, his right on board the ship extending no further than the ship's rail; alternatively, contributory negligence was alleged.

Plaintiff stated that in his 30 years' experience he had never had challenged his habit of seeking dunnage, for use in his work, on the deck level of a ship. While looking for dunnage he tripped over a bag in the darkness and fell down the hatch.

On behalf of the defendant company, the manager of the stevedores claimed that dunnage should not be taken from a ship's hold without permission of a ship's officer. To stow a modern ship to-day required dunnage to the value of hundreds of pounds sterling.

A foreman stevedore of 50 years' experience said that an employee of receivers of cargo should not wander about a ship looking for dunnage without asking permission. He was not speaking of stevedores.

Of one witness the Judge asked: Do you mean to say the dockers do not work when it is raining—irrespective of the type of cargo? to which the reply was given. Yes; we have a wet weather clause.

The Judge decided that plaintiff was legally a trespasser, and contributed to his own disaster by contributory negligence.

Note—With regard to the alleged "wet weather clause," enquiries show that in the port of London at any rate, no such restriction is enforced, the decision as to working in wet weather being left to the discretion of the parties concerned.

2. Improper System of Unloading Cargo

Another claim for damages, this time arising out of an allegation of improper unloading conditions, was heard on July 7th and following days in the King's Bench Division, before Mr. Justice Hilbery. The plaintiff, Mr. Daniel Holland, alleged that owing to an improper system of unloading a ship at the Surrey Commercial Docks on March 15th, 1939—or alternatively to the defendants' alleged failure to employ a competent foreman—he was struck by a bundle of box boards which fell from a scale board. His skull was fractured, and he received other injuries.

The defence was a denial of negligence. Defendants (Hays Wharf, Ltd., of New Hibernia Wharves, London) also contended that if there were any negligence it was casual negligence on the part of an employee and the doctrine of common employment arose.

Opening the case for the plaintiff, Mr. Russell Vick said the action arose out of the unloading of a ship. The plaintiff was a stevedore employed by the defendants, and he claimed damages for personal injuries suffered through the employment, plaintiff alleged, by the defendants of an improper system of unloading. Alternatively, he alleged that there was failure to employ a competent foreman. The defence was that there was no negligence, and that, if there were, it was the casual negligence of a foreman, and the doctrine of common employment was raised.

Counsel continued that the accident happened just before noon on March 15th, 1939, when the plaintiff, with other members of a gang, was in the lower hold of a vessel from which bundles of box boards were being discharged into barges. When no barge was alongside the loads of box boards were lifted from the hold and put on the deck. When a barge came alongside it was necessary to clear the deck, and the plaintiff alleged that the hatchway man, unassisted, put the rings of the chains into the crane hook and gave the signal to lift. On the occasion concerned a chain caught under the scale board, with the result that it tipped and some of the box boards fell on the plaintiff. Plaintiff alleged that there was negligence in not having two men to deal with the bundles when they were being lifted from the deck. He was unable to do his normal work as a result of the occurrence, and was now doing a light job on a farm at 30s. per week.

Mr. A. W. Cheesman, outside foreman stevedore to Messrs. Gee & Co., stevedores, said that after cargo had been hoisted to the deck, two men besides the hatchwayman should have been employed to see that the chains were in proper position when the craneman lifted the scale board from the deck to the barge. In his experience, a "chandelier" and a canvas-and-wire preventer were used for hoisting.

Evidence as to the practice followed in unloading box boards was also given by Mr. H. W. Lewis, a foreman stevedore of 30 years' experience. He said two men would be employed when the scale boards were picked up from the deck.

Similar evidence as to the need for two men was given by Mr. J. W. Welsh, a foreman stevedore with 40 years' experience in the Port of London.

Mr. St. John Field, cross-examining, suggested to each of the last two witnesses that if the set of box boards were on deck it ought not to have been there, and the witnesses agreed.

*Condensed from Reports in "Lloyd's List."

Legal Notes—continued

Counsel observed that according to the defendants' rules it was not permissible to put the sets on deck.

Mr. J. R. Thurston, driver of the crane at the defendants' wharf on the day of the accident, said he was ordered to put the set on the deck. He was not aware that that was wrong, and it was the usual practice at another wharf owned by defendants. He had always lifted off the deck with only one man looking after the set, and though occasionally goods had fallen down the hold there had not been an accident before the present.

Answering Mr. St. John Field, witness said he believed it was a standing order of the defendants that cargo must never be put on deck if it could be helped. His own position was that he was a craneman under orders.

The plaintiff further alleged that complaints had been made about the hatchwayman, Charles Widdows, as a hatchwayman. He was a very good worker in the hold and a very decent man; he did not think that any complaint about Widdows had been made to the Joint Safety Committee, consisting of representatives of the man's trade union and of the employers.

Mr. Holland, answering further questions, said he had never heard of a standing order that sets should never be put on deck if it could be avoided. He added that he always worked in the hold, and the practice there was to have two men to hook the hoisting chains on to the scale board. It was the practice for sets to be put on deck which witness said was dangerous. He had not made any complaint to the Joint Safety Committee because he thought it was the usual practice.

Re-examined by Mr. Russell Vick, the witness declared that there were never two men working on the deck.

Mr. Charles Henry Scott, a stevedore of 20 years' experience, said it was the practice to put sets on deck when unloading box boards, in order to clear certain marks. The defendants would not allow more than one man on deck.

Cross-examined, the witness said he had never been told that a set must not be put on deck if it could be avoided, nor had he been told that two men must be on hand to put the chains on the scale board. It would be simple for the hatchwayman to get a man out of the hold to put on the chains.

Other stevedores and dock workers were called on behalf of the plaintiff to give evidence as to the practice followed in unloading box boards.

Mr. Joseph Owner, factory inspector at wharves on the Middlesex side of the river, said the scale boards used in unloading the box boards at the time of the accident were about 6-ft. by 4-ft. 8-in., and they had three eye-bolts on each side. It was the general practice to place sets of box boards on deck if there was no barge alongside, in order to expedite discharge. The practice, in picking up from the deck when the barge came alongside, was to have a man on each side of the scale board to see the chains came up fairly when the crane driver took the weight, and to see that no edge of the scale board fouled anything that might be on deck. In his opinion it would be dangerous to work with one man only.

This concluded the evidence for the plaintiff.

Opening the case for the defendants, Mr. St. John Field suggested that there was no case for them to answer. Of the eight headings of negligence alleged in the plaintiff's particulars five were solely directed to alleging that Widdows, the hatchwayman, was incompetent.

Mr. Falknor Spiller Channer, now superintendent at Cotton's Wharf, and superintendent at one or other of the defendants company's wharves since 1921, said there was a very definite rule as to how delivery should be made from a ship direct into the craft. The rule—which was not written—was that when a set of box boards was picked out of the hold for delivery into a craft it must go into the craft in one action. If the craft were not alongside the job must be stopped or the box boards put on shore. There might be an exception if, for instance, it was seen that a set coming out of the hold was not properly slung. The set would then be put on deck so that it could be made safe. There was also an unwritten rule that when a set had been placed on deck two men should be present when it was lifted again. Two men were necessary to guide the chains attached to the scale board and to see that they did not catch in the sides of the set and "spew the stuff out." There had never been a complaint to the Joint Safety Committee of the trade union and employers' representatives as to the method of discharging cargo, nor a suggestion that it was dangerous or anything of that kind.

Answering Mr. Justice Hilbery, witness said that to put sets on deck would impede the unloading of the vessel.

This concluded the evidence, and counsel addressed the Court.

Mr. St. John Field said that so much had vanished from the case that all that was now left was an allegation that the defendants employed a wrong system. The burden of proof was on the plaintiff to show that a wrong system was used, and that that system was dangerous, and he had entirely failed to prove either of those things. The defendants' system was all right, but the particular hatchwayman concerned—who was obviously in common employment with the plaintiff—had departed from his duty on the occasion with which the action was concerned.

Mr. Russell Vick, for the plaintiff, submitted that his Lordship could find that there was not a proper system and effective supervision in handling the box boards, and that the plaintiff had established his case aginst the defendants.

Judgment

Announcing his findings in favour of the defendant company, Mr. Justice Hilbery said the case had given him considerable anxiety. The plaintiff had brought his action at common law, but had rightly kept open his right, if his action could not be established at common law, to claim under the Workmen's Compensation Act for what was undeniably an accident arising out of and in the course of his employment.

The plaintiff, when engaged in unloading the ship concerned, was a member of a gang—the second preference gang—composed of 12 men, every one of whom was thoroughly experienced and skilled in that type of work. In the action the plaintiff had alleged that, in providing Widdows as a hatchwayman, the defendant company had failed to select a fit and competent servant, but his Lordship found that in so far as the case rested on that allegation, it was not made out at all. The other part of the plaintiff's case was that it was part of the system employed by the defendant company that sets of box boards should be placed on deck if there was no barge alongside to receive them, and that the hatchwayman alone should attach the chains from the scale board on to the crane hook when the time came for a set to be lifted into the barge. It was not established at all that there was any danger in putting the set on the deck.

There was no doubt that the detail of how the work was to be done was so well understood both by the employers and the skilled men who did the work that one did not find an elaborate code of directions and rules anywhere. Certainly the officials of the union to which the men belonged—the Transport and General Workers' Union—knew every detail of how the work was usually done. Having heard the evidence, his Lordship was satisfied that the general rule upon which the men worked, and which they fully understood, was that the deck of a ship that was being unloaded must be kept clear. That fundamental rule was not made because to lower a set on to the deck was of itself dangerous. It was not. The rule was framed so that the deck could be kept clear and not impede the unloading. But like every rule, there was occasional exceptions. It was said for the plaintiff that there was always an exception to the rule when the appropriate barge to receive the box boards was not alongside the vessel, which, it was said, frequently happened. On the other hand, the evidence for the defence was that it did not frequently happen, and that to put sets on deck was not their recognised procedure.

The crucial question was whether it was true that a part of the system employed by the men and well known to the defendant company was to place the sets on deck until the appropriate barge arrived alongside, and for the hatchwayman alone to attach the chains to the crane hook when the sets were rehoisted. The defendants' evidence satisfied his Lordship that the prime rule was that sets should be placed on the quay if they were brought up when no barge was alongside, and it was not established that, as part of their system, the defendants caused or permitted sets to be lowered on the deck and then dealt with by the hatchwayman alone. There was help available for the hatchwayman, which he could have obtained.

How the accident happened was plain. The hatchwayman had allowed the loaded set to be put upon the deck because the barge was not alongside. That of itself was an improper thing to do. It was not, however, that improper act which was the cause of the accident, except incidentally. But when he came to have it rehoisted he got no help in rechaining, and a chain became fouled under a corner of the scale board. On the occasion concerned Widdows was guilty of negligence and it was his casual act of negligence which caused the accident. But it was not, in his Lordship's view, established that Widdows' actions were part of any system caused or permitted by the defendants. That sufficiently answered the matter.

His Lordship added that if he had been able to find in law that the plaintiff's case was made out, he would have awarded him £850, but he could only say that he regarded the case as not made out. On behalf of the plaintiff, it was intimated that there might be an appeal.

Awards for Gallantry to Port of London Workers.

An interesting ceremony took place in Trinity Gardens, London, on July 22nd, when Mrs. Winston Churchill presented a representative selection of gallantry certificates which had been awarded to members of the staff of the Port of London Authority who have performed acts of gallantry or who have been conspicuous for their devotion to duty during air raids in the Port of London.

Notes of the Month

South African Shipping Delays.

Complaints of shipping delays in South African ports have given rise to an agitation for greater speed of port operation and a wider distribution of shipping among the ports.

Newport Harbour Board.

At the 104th annual meeting of the Newport (Mon.) Harbour Commissioners, Councillor T. F. Mooney was elected chairman and the following new members were appointed: Messrs. William John Horton, Edward Donald Williams, and T. Bert Price. The new members represent miners and workers in coal.

Proposed Developments at Trieste and Fiume.

Reports have appeared that the Italian Government intends to "revitalise" the neighbouring ports of Trieste and Fiume, the latter of which is in Croatian territory, recently acquired by Italy. It is proposed to make Trieste an industrial port and Fiume is to be constituted a Free Port.

Port Talbot Dry Dock Company.

The report of the Port Talbot Dry Dock Company, Ltd., for the year ended 31st March last shows a profit for the year of £.128. The directors have recommended a dividend of 5 per cent. as compared with 4 per cent. in the previous year, which was the first to be paid for 10 years.

Port of London River Emergency Service.

An inspection of the personnel of the Port of London River Emergency Service was made early in July by the Lady Mayoress of London who was accompanied by the Lord Mayor (Sir George Wilkinson) and their daughter. The inspection included a visit to two ambulance ships moored at the Westminster Pier.

Trade Revival at Southern French Ports.

From statements in the *Journal de la Marine Marchande* it appears that there was a revival in trade last winter at ports in the Etang de Berre, in Southern France. In particular, heavy cargoes passed over the quays at Caroute and seven cod-fishing vessels from Newfoundland discharged about 5,000 tons of fish at the Port de Bouc.

Tyne Commission Staff Changes.

Mr. W. H. Dickinson, B.Sc., M.Inst.C.E., Resident Engineer at Tyne Dock, has retired from the service of the Tyne Improvement Commissioners for reasons of health. Mr. H. R. Hogarth, an assistant engineer in the chief engineer's department has been appointed to succeed him as resident engineer, as a temporary measure during the war period.

Presentation to Sir Lionel Warner.

On the occasion of his retirement from the general manager and secretaryship of the Mersey Docks and Harbour Board at the beginning of July, Sir Lionel Warner was the recipient of a gold cigarette case subscribed for by members of the Board's staff as a token of their regard. Warm tributes to the value of Sir Lionel's service were also paid by the Board at their last meeting in June.

Progress of Cape Town Harbour Works.

The main development at the new Basin in the Cape Town Harbour Scheme is stated to be making satisfactory progress, though it appears to be doubtful if the whole will be completed by the end of the current year. The new deep water berths "A," "B," "C" and "D," which the elbow forming one side of the entrance to the Basin and the whole of the quayside on the North side of the Basin contains, are completed and the quay wall forming the foreshore side of the dock and which will, when completed, provide the quayside for the deep water berths, "E," "F," "G" and "H," has been completed to a length of 3,031-ft., while foundations have been laid over a distance of 3,400-ft. out of 4,000-ft. required.

Calcutta Dry Dock Entrance.

When the King George's Dock, Calcutta, was constructed, dry docks in tandem were arranged alongside the lock entrance with a view to the possible utilisation of the dry docks entrance as an alternative to the normal entrance in an emergency. The river frontage to the dry docks has since silted up and the cost of continuous dredging to clear the approach is considered to be prohibitive. Accordingly, the dry dock immediately adjacent to the river is only accessible by passing through the inner dry dock. As it is impracticable to maintain permanently the river entrance to the dry dock, the outer caisson is rendered superfluous and it has been decided to replace it by a bund, which can be removed as easily as the accumulation of mud, leaving the caisson free for active use elsewhere.

Port of London Authority Staff Committee.

Mr. A. K. Graham has been elected Chairman of the Staff Committee of the Port of London Authority. Mr. Graham, who is one of the representatives of the "Goods" section of the port electorate, has been a member of the Board since 1935.

National Harbours Board of Canada.

The annual report of the National Harbours Board of Canada shows record operating revenues in 1940, amounting to $10,602,199, or more than $1,500,000 over those of the preceding year. Administration and operating expenses came to $4,506,827, an increase of $248,000.

Hong Kong Harbour Development.

At the annual meeting of the Hong Kong and Whampoa Dock Company, Ltd., the chairman, Mr. J. J. Paterson reported the completion during the past year of the purchase from the Government of a part of the foreshore out to deep water on the East side of the East Yard and that a deep water berth was to be formed there. The foundations for the sea wall are now under construction.

Tyneside Pilotage Service.

New offices of the Deep Sea and Coastal Pilotage Services have been opened at Sandhill, Newcastle. The ceremony was performed by Captain H. R. B. Kent, an ex-master of Trinity House, Newcastle. Captain Marsden, honorary secretary of the organisation, stated that since the war began members had piloted more than six million tons of shipping without loss, except for a small percentage through enemy action.

Canteens at Liverpool Docks.

The Mersey Docks and Harbour Board have authorised the expenditure of £15,955 for the provision of a further twelve canteens for the benefit of dock workers at Liverpool and Birkenhead and the work is well in hand. There are already 40 such canteens in service on the dock estate and more will be provided as circumstances require.

New Floating Dock at Vancouver.

It is announced by the Burrard Dry Dock Company of Vancouver that they are constructing a new floating dock for the accommodation of ordinary type freighters, as an auxiliary to their existing dock which has a lifting capacity of 15,000 tons. The estimated cost is 600,000 dollars and the work will take about a year to complete.

United States Programme of Harbour Development.

The Rivers and Harbours Committee of the United States House of Representatives has approved an expenditure of $281,872,000 on a "navigation-improvement" programme to be carried out when the expenditure "will not materially interfere with national defence measures." A number of projects relating to New York Harbour and the River Hudson are included in the programme.

Rapid Wharf Construction in Canada.

A Canadian Journal (*The Engineering and Contract Record*) relates that a small wharf, 120-ft. long and averaging 35-ft. in width, has been built on the south shore frontage of Lake Ontario within the remarkably short period of 12 days. There were approximately 700 lin. ft. of round timber piling, which was driven in six days, the remaining time being occupied in constructing the 6-in. by 10-in. timber framing and 3-in. plank decking.

New Floating Dock at Baltimore.

The construction of a new floating dock is in progress at Curtis Bay (Baltimore), Maryland, U.S.A. It is of the U-shaped self-docking truss-sectional type, with steel wing walls and pontoons of yellow pine, with a single layer of sheathing and a decking of Douglas Fir. It will have 5 sections and with a lifting capacity of 3,000 tons, it will be able to accommodate ships up to 350-ft. in length, 50-ft. beam and a draught of 20-ft. Two slipways are also under construction for the reception of vessels, 350-ft. by 42-ft., and a displacement of 3,000 tons.

Fire Prevention at British Ports.

In the House of Commons recently a question was asked by Mr. D. Adams as to whether it was intended to make protection of British ports against enemy action a stabilised national service in place of the existing practice of entrusting the matter to port authority personnel in conjunction with the local authorities concerned. The Parliamentary Secretary to the Ministry of War Transport (Col. Llewellin) replied that the dock authorities would remain responsible for fire prevention. Arrangements were in hand to secure better co-ordination between those authorities and the local and national services.

Ship Salvage in Harbours and Docks

A Difficult and Hazardous Operation

By "NORTHFLEET."

Development of Salvage Operations

THE salvage of ships and their cargoes in the Ports and Harbours of the World was in a primitive state until the utility of the surface condensing engine was established. Then came the steam capstan and the steam winch. Later, when the manufacture of heavy lifting wires became of use to salvors, a further impetus was given to the subject, especially in raising vessels from the bed of a tidal river by means of Camels, as flat lifting pontoons are now called. In the year 1887, the sailing ship *Locksley Hall* lay sunk in the River Mersey, so close to the Mersey Railway Tunnel that it was inadvisable to use explosives to blow the wreck to pieces. The Thames Conservancy at this time had been concerned with the London firm of Bullivant and Co., in the use of lifting wires. powerful mechanical purchases, because there are many places in the Mediterranean, for instance, and also in the Caribbean Sea, where there is no appreciable range of tide and where the conditions are of a highly suitable type for salvage work, especially for diving. In European estuaries, divers can seldom see the wreck they are working at. Sand, mud and other flocculent detritus prevent clear vision. In the Mediterranean and the West Indies, it is possible to see many fathoms deep during a day of bright sunshine. Camels with powerful tackles and wires should now be constructed to raise a weight up to 8,000 tons if necessary, for, in this way only, can a large category of tonnage be salved, which is now lost to the owner and underwriter. Some ships are more vulnerable than others from their design. This will be appreciated by study of the plans (Fig. 1) showing the 3 and 5 compartment ships and the tanker.

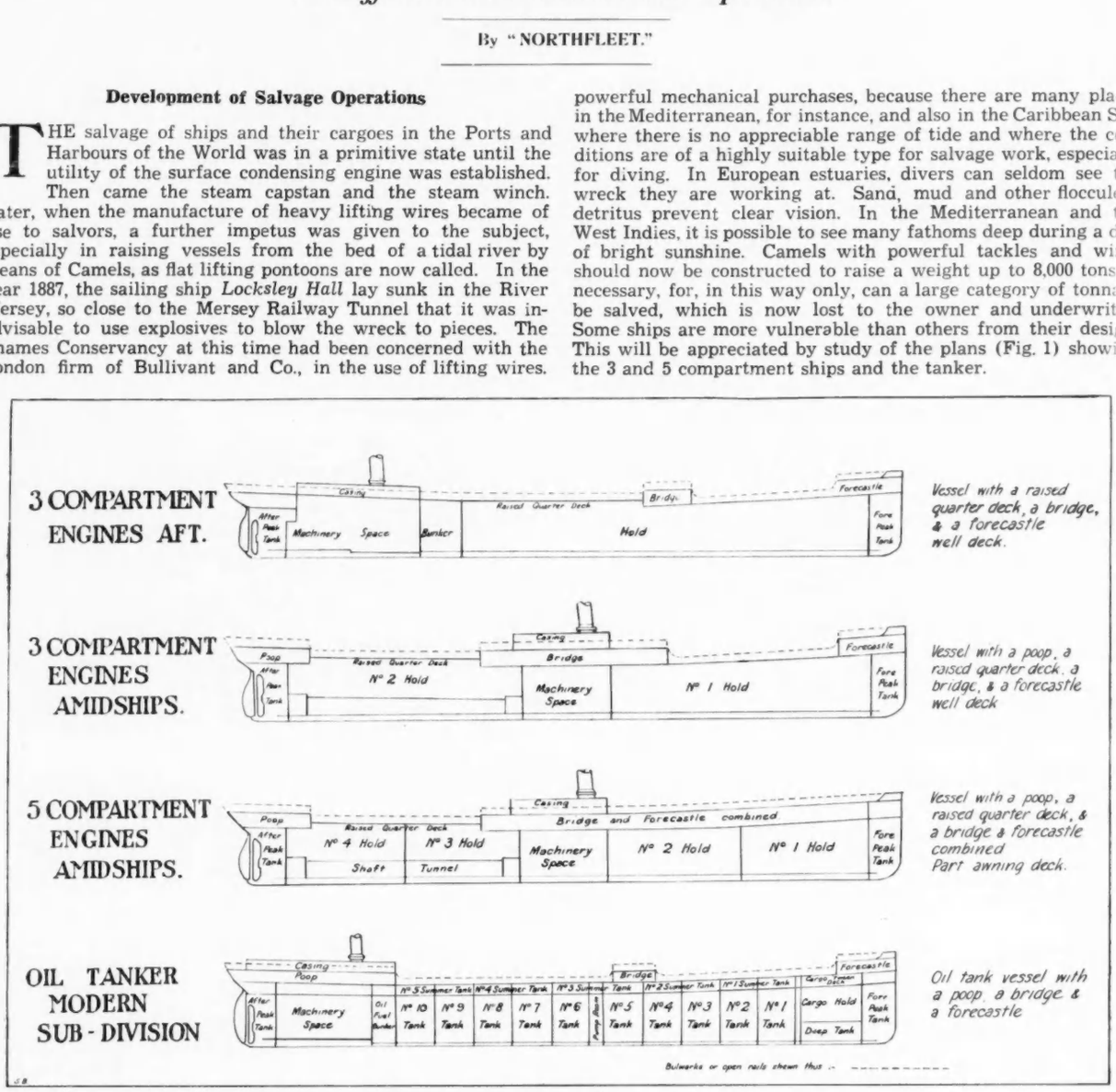


Fig. 1. The Merchant Ship: Diagrams showing Order of Vulnerability.

This firm, the pioneers of heavy wire manufacture, produced a set of wires having eight inch circumference, and formed a syndicate to undertake the operation for the lifting of the *Locksley Hall*. The tonnage of this sailing ship was 1,356 gross. After some preliminary difficulties, the wreck was successfully raised between hulks specially adapted for the work.

A point important to this operation was that the officer in charge did not attempt to raise until neap tides were established, arguing that the spring tides, notwithstanding their greater vertical lift would jeopardise the transit of the wreck shorewards in days when tugs were not so powerful as they are now. Tidal currents would then be running at 5 knots. This caution was fully rewarded and the wreck was carried about a mile from the submerged position to the dry land in several stages, with the tidal current at 2 to 3 knots. It is this pinning with heavy wires to a submerged wreck, followed by tidal lift and a carry inshore,with a partly submersible camel, which is the essential feature of this form of salvage and it is consequently limited to areas where there is a considerable tidal range. The *Locksley Hall* salvage proved what could be done by using the range of the tide and subsequently more difficult cases have been dealt with, as a matter of course in the Mersey, Thames and elsewhere.

At Liverpool, the range of spring tide is about 31 feet at springs and 21 feet at neaps. London River falls short of these figures by 10 feet. In the Bristol Channel and Bay of Fundy, the ranges soar to 40 feet and more, with a consequent swiftness of the tidal current. There remains something to be done now in the direction of wreck raising by camels fitted with more

Compressed air as an auxiliary

Compressed air can be employed to assist in the raising of wrecks held by wires. As a method adequate in itself, compressed air now has a distinguished record of success, and records of some achievements of recent years follow in these pages.

To explain adequately the variety of salvage operations in tidal rivers and harbours is hardly possible within the compass of this article. There are vessels beached by pilots after collision requiring the quick expedients of patch and pump, and also those that sink in deep water before beaching can be effected. The number of these that are light in weight, allowing for raising to be completed by one tidal lift into shallow water for doctoring by the shipwright are considerable.

The Coffer-dam in Salvage

The coffer-dam method of salvage takes its distinction from the early achievement of Mr. Armit of the East Coast Salvage Company in 1891, when he raised the Anchor Liner *Utopia* from Gibraltar Bay by taking advantage of smooth water with no appreciable rise and fall of tide, and the fact that the ship's upper decks were awash, while the liner was in an upright position, but with a list. This coffer-dam method has been consequently employed in docks where it is not expedient to run the dock levels down and so place valuable ships unloading berths on the ground, delaying their sailing or causing a suspension of cargo work. A grain elevator, sunk in dock at Liverpool, was raised by this method which required much of the work of the coffer-dam being fixed under water by the divers. Figs. (2) and (3)

Ship Salvage in Harbours and Docks—continued

demonstrate this method of raising the ship's structure to atmosphere levels after which pumps to clear the way and parbuckles to prevent toppling may be used.

The Uprighting of Capsized Vessels

Next in order of importance in dock water salvage comes the capsized ship. This again presents a problem of expediency in salvage. Dock systems are usually inter-communicating for the maintenance of a common level of water, so that deep draughted ships can pass and re-pass as the tides occur for sailing or arriving. The author has participated in one such uprighting of a loaded ship after capsizing, in which the operations covered three winter months, and were extended due to the need for maintaining the water level in the dock, as much as possible. Be it said at once that uprighting by using a full parbuckle on a ship resting in the mud on her beam ends may be damaging to the upper works of the ship and probably to the bilge keels. In the writer's experience, shore purchases to assist the parbuckle and lessen the severity of the pull are desirable.

Parbuckling increases the straight pull by 100 per cent. and consists in utilising leverage with the pulling component. Assuming a ship falls away from the wall alongside which she is moored, as occurred in the case mentioned, if a parbuckle is used then the uprighting wires are passed from outside inwards under the ship, no easy matter when 8 or 10 wires of approximately 9 inch circumference are required. The ends are then passed up between the quays and the ship's bottom plating (now vertical) and secured either to a frame, bolted to the upper deck, or shearstrake plating, or to bollards of special construction which must be bolstered from inside the ship to the side plates. Sometimes the wires are taken in board around hatch coamings or masts. It is therefore inevitable that the shearstrake and such parts to which these wires are secured, or bottoms fixed, will leave their scars on the smooth sides of the vessel. Parbuckle wires are usually secured to lifting craft outside of the vessel with the combined shore and camel operation.

The Salvage of the "Segovia"

Among these puzzling operations the raising of the s.s. *Segovia* at Newport News in 1932 is, in the writer's view, the *chef d'œuvre* of this kind of work. A vessel of 7,000 tons gross, 447 feet overall and 60 feet beam, she lay in the builder's yard approaching completion when fire broke out during the night of December 19th, 1931. The ship lay starboard side to the fitting-out Pier No. 1, with a slight list inwards or to starboard, due to the stacking of the chain weights (in use during the previous day for testing the derricks) on the starboard side. At 7 a.m., the ship took a heavy list to starboard, due to the slack water which had been poured into the ship in efforts to extinguish the fire, and at 8 a.m. the ship rolled on to her beam ends and sank, so that two-thirds of her structure was submerged, her masts lying towards Pier No. 1. After a careful study of the dynamics of the problem, uprighting operations were commenced on the 2nd March, 1932, and on the 19th March—17 days later—the vessel entered dry dock, which must be recorded as a triumph of shipyard organisation and salvage. Ten electric winches were employed, driving *thirty purchases* having five sheaves at the ship-end and four sheaves at the anchored end. It was perhaps fortunate that these winches were available as they possessed three drums each and were capable of a pull of 8 tons per drum or approximately 23 tons per winch. To provide factors of safety, the purchases were each of 50 tons capacity and were led from the upper deck of the vessel to Pier No. 2, which formed the stage for the winches and their anchorages. The funnel, masts, rigging, davits and boats were cleared away. The adhesion of mud to the underside of the ship was the greatest unknown factor, and it was decided to allow 25% of the vessel's weight, including the mud in the hull, against this retardation stress. The calculations showed that there was not a serious possibility of the vessel rolling over when uprighted in the opposite direction, due to her beam of 60 feet. The restraining wires were required to prevent the vessel *sliding bodily towards Pier No.* 2 when heaving was commenced. Dynamometers consisting of railway car springs with dial attachment were fitted after calibration on the standing part of each tackle, to enable the winch operators to obtain as nearly as possible equal pulls on all tackles. Each bracket for a righting tackle was tested to 50 tons pull at right angles to the shell by means of a hydraulic jacking device, fitted with a pressure gauge. The restraining units consisted of eight steel wire purchases, four at each end of the ship attached to the hull, where the lines of the ship were fined away; these were passed under the ship and secured to brackets fitted above the water line on the bilge strake, on the port or exposed side. From the port bilge, the wires passed under and upward the starboard side to a purchase in the opposite direction to the righting tackle. It is not necessary to give details of these restraining tackles and the anchorages other than, at test, they were put to a strain of 480 tons on one and 150 tons on the other. The spring tidal rise at Newport News is 2 feet 9 inches. Dredging was carried out to remove the silt alongside the Pier, and in this connection, one concludes from diagrams that the contours were conducive to the ship sliding outwards when filled with unconfined water, in addition to the inclination of the list to starboard.

In uprighting when the heaving of the *Segovia* was commenced, the centre of gravity had moved to the bilge at 55 degrees; at 7.29 a.m., the slack of the tackles had then been taken in and a pull of 1,200 tons registered. This was near to the 1,240 tons estimated to be overcome before righting would occur. At 7.31 a.m. the list had decreased to 29 degrees. The final maximum pull was 1,370 tons (tons were long tons of 2,240 lbs.),

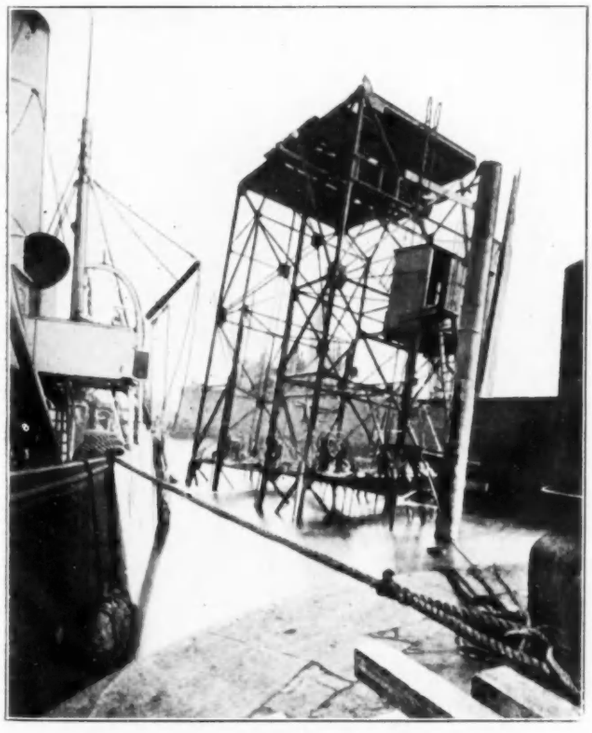


Fig. 2. Grain Elevators before Cofferdam was fixed.

Fig. 3. Cofferdam in Position.

Ship Salvage in Harbours and Docks—continued

ending with the vessel having a list of 13 degrees, which after settlement became 10 degrees, making the vessel almost upright. The ship was then pumped out and the same mathematical care exercised in computing the effect of clearing compartments as was employed in the preparation for uprighting. In such a position with the management in full control of the locality for setting up purchases—a strong technical division—the ship free of any cargo or bunkers, there were elements of advantage not usually present in a seaport or dock as a rule in salvage. The calculations and organisation were a commendable example of using technical and mathematical skill previous to the practical work being commenced.

Patch and Pump

The major number of salvage cases in docks and harbours are of the "patch and pump" order. Vessels beached usually dry out partly at low tide, because high tide is the usual period of tide for harbour casualties, when movement is greatest. The photographs show a 4,500 net reg. vessel beached and patched.

Cases have occurred where several damaged ships which were in reasonably stable condition have sunk to the bottom of the dock and remained upright. This was primarily due to the absence of a bank of clay or mud alongside the quay—a useful matter for Dock Authorities to note. The *Segovia* slid away from the quay as she sank, due to a mudbank alongside the Pier No. 1.

At this point, the writer urges port salvage officers to avail themselves of shipyard knowledge by obtaining from the builders the precise weight of engine boilers and materials when a heavy lift is required. Ship builders are most obliging in this respect. The author has known vessels which were beached in a badly fractured condition. which, after patching, were taken off without any calculations as to the amount of compensation required to prevent the ship buckling or bending. The result has been a loss and/or great expense. Given careful dimensions of the fracture and the builders assistance, no such vessel need be lost to the salver *provided the weather is fair.*

(To be continued)

Fig. 4. At low tide, after beaching, the extent of damage becomes visible. Note the compensative stiffener temporarily fitted across fracture to maintain longitudinal strength.

Fig. 5. At half tide, the diver returns to his seat in the diving boat, after his helmet has been removed.

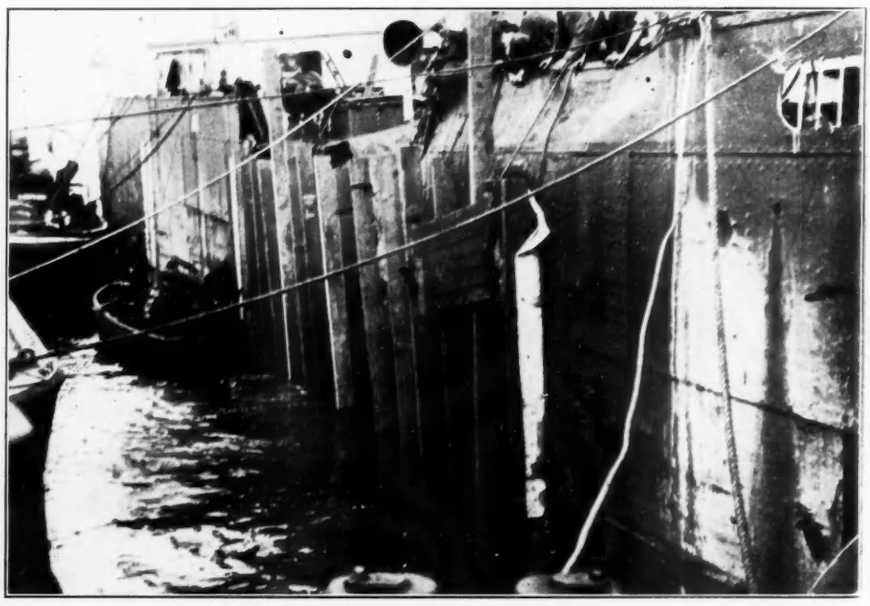


Fig. 6. The patch or shield, approximately 40-ft. by 30-in., is lowered into position and the diver has gone down to ascertain if it is a good fit. This shield was altered twice to obtain security for floating.

Port of New Orleans Traffic.

According to a report of the United States Corps of Army Engineers, a record volume of tonnage was dealt with during last year at the Port of New Orleans, Louisiana. This report stated that a total of 19,795,599 tons of cargo moved through the port during 1940, and exceeded a previous high record by more than 2½ million tons. Total imports for New Orleans aggregated 2,896,269 tons, while exports totalled 3,351,177 tons. The coastwise movement for the year amounted to 5,366,326 tons, which included shipments of 3,544,471 tons and receipts of 1,811,755 tons. Internal receipts were shown by the report as 5,240,960 tons and internal shipments were 2,940,867 tons. Vegetable food products were the principal item of import. Other principal imports included animals and animal products, 82,986 tons; vegetable products, inedible, 119,411 tons; textiles, 131,596 tons; wood and paper, 83,018 tons; non-metallic minerals, 375,238 tons; ores, machinery and vehicles, 169 tons; and chemicals, 96,730 tons.

*Cold Storage Facilities in Port Development**

Advantages and Disadvantages

By GEORGE OSGOOD,
General Manager and Chief Engineer, Port of Tacoma

In presenting this paper on Cold Storage Facilities in Port Development I shall confine it principally to its application on the Pacific Coast, for two reasons—it is being delivered before the Pacific Coast Association of Port Authorities and I am personally more familiar with conditions on this Coast than in other sections of the Country, or abroad.

I trust that the two gentlemen assigned to discuss the paper will hit from the shoulder and not hold back in an endeavour to save my feelings, I am sure they will not, because they both know I am used to being knocked about and enjoy an argument any time one is brewing; furthermore, this Association has been noted throughout the years of its existence for frankness and open-mindedness in dealing with the problems that come before it.

I shall endeavour to present the subject in a general way, followed by the advantages, as I see them, in establishing cold storage facilities at tidewater and then the disadvantages, finishing with conclusions that seem pertinent to me.

It is assumed that any community considering the construction of a cold storage plant will, before its actual building, have made a complete survey and definitely determined to their entire satisfaction that there are commodities available in sufficient quantities and within range of competitive freight rates—both rail and motor, to make for an operation that will not only serve to provide facilities for producers, exporters and importers but be reasonably sure of making at least a small return on the investment—I mention this because I am sure that a great many port developments have been made without any regard as to whether or not the community they seek to serve is particularly benefited by their existence and without the least thought to the economic problem they present for the community that has to support them, from the inception of construction on through an ever-mounting maintenance period. In my humble opinion, we have in this country, and the Pacific Coast is not to be excluded, created too many Port Authorities, who in turn have gone on more or less blindly with a construction programme that has not been economically sound, with the result that these developments, so built, have not created any more commerce but have simply divided it up, which tends to destroy a freight movement that should properly go through a strategically located Port and allowing such a Port to reap the profit that it is justly entitled to enjoy.

Location

In constructing a cold storage plant at tidewater, two problems are distinctly present in the actual location—whether to build in deep water frontage with a dock apron for the berthing of vessels in handling commodities directly to and from ship's tackle, or build the plant directly behind a transit shed, handling through the shed in conjunction with ship's tackle. Personally, I prefer the location behind a transit shed as it lends itself to a better arrangement for railway tracks and motor truck roadways; furthermore it is very questionable whether a dock front location is warranted from the standpoint of first cost and maintenance when the dock is used for intermittent vessels loading refrigeration cargo solely, while the position behind a shed permits the handling of general and refrigerated cargoes at the one berth position and at the same time.

Platforms for the receiving and delivery of goods are essential to quick dispatch and should run the full length of the structure on both sides, preferably indented, with a wide connecting aisleway through the centre of the building—railway tracks serving the structure on one side and motor truck roadway on the other —with both depressed for car-door and tail-gate loading.

A multiple storey plant, not exceeding four in height, lends itself to economical handling if large corridors are provided on each floor with storage rooms opening into the corridors adjacent to a high speed elevator with plenty of platform area and a capacity of not less than four tons. Of course that kind of a plant can be expanded in units with the same corridor situation for each unit.

Compressor capacity and piping depends, of course, on the size of the plant and is more or less standardised at this time, but it is essential to have compressor units of various sizes to give flexible operation in accord with the seasonal productions of commodities and with regard to the saving in fuel consumption.

Insulation

Insulation is a very important factor—only the best of materials available should be employed and placed by skilled mechanics without regard to cheapness of construction, as a well insulated plant will pay dividends while a poor one will cause much trouble, resulting in leakage of refrigeration, as well as of profits, besides the danger of damage to goods in storage.

In recent years much attention has been given to the quick freezing, in loose form, of all kinds of berries, fruits and vegetables, with a surprising market demand for such commodities, with retail stores rapidly installing equipment to carry them for their customers. Considerable experimental work has been carried on with the result that to-day this is an established business and one that is bound to grow to large proportions, and I am convinced that in a few years we will be freezing and storing a more diversified number of foodstuffs in ever-increasing quantities. Equipment for this process can be installed in an existing cold storage plant, or built in at the time of original construction with equally good results, and at the present time the tunnel method of freezing, both for packaged and loose frozen commodities is, I believe, the best and allows a greater capacity, although other methods are in use and have proven satisfactory under certain conditions. Any cold storage plant located in close proximity to a producing area is adaptable to quick freezing, if the time consumed in transporting fresh vegetables from the fields to the plant does not take excess of two hours although asparagus, berries and fruits have been successfully transported to the plants by over-night carriage in reefer cars lightly iced, Cold storage facilities at tidewater under Port Authority ownership and operation are very adaptable to this class of business, both from a freezing and storage standpoint, due to their accessibility to all forms of transportation that permits the least amount of handling, which in turn allows lower costs. This is a subject that may well be treated in detail at some future Convention of this Association. I mention this because I think it would be of interest to this group, possibly not next year but two years from now, when this method of freezing has been more fully developed—not the owner of a cold storage plant or the operator of it—but some company that is handling their products through that plant—and have them present a paper on the results both of freezing and marketing.

Ozone-generating equipment, either built in or portable (preferably the former) is a very essential factor in properly caring for commodities in cold storage, such as eggs, fresh fruits and vegetables, preventing to a large degree the formation of mould as well as retarding shrinkage—two conditions that must essenally be guarded against.

Cooling Water

Sea water is commonly used in plants located at tidewater for the cooling of ammonia condensers. This water is, however, detrimental to the condenser tubes, deteriorating them quite rapidly. Therefore, if fresh water is available at low cost, its use is to be preferred. On Puget Sound we use sea water for the reason that it has a low temperature and the temperature does not vary between summer and winter to exceed approximately six degrees, and if we buy fresh water, the rate is quite high, so that the deterioration of the tubes by the use of sea water is compensated by the high cost of the municipally owned water delivery.

Ice Manufacture

The manufacture of ice for local commercial distribution is a function of most cold storage plants, but I question the advisability of this phase of the business by tidewater plants municipally owned and operated, as it throws them into a trade that is quite foreign to the rest of their operations, placing them in the retail delivery business that to my mind has no place in the Port Authority functions. In the State of Washington port-owned and operated cold storage plants are prohibited by Court order from entering the retail ice business. It is, however, entirely feasible for them to have a small icemaking plant for the icing of cars and fishing vessels that are loading at Port terminals. Where no ice is produced at the tidewater plant, adequate track facilities should be provided for the rapid icing of cars through truck delivery and portable elevators.

I shall not in this paper attempt to cover the processing, freezing and storage of fish, principally because my knowledge of this important business is from observation rather than actual practice and it is necessarily handled separate and apart from the general cold storage business. The fishing industry is a very important factor on this coast with large sums of money being invested in fishing vessels and equipment used in conjunction therewith, so it necessarily follows that the cold storage facility is an important factor in meeting present-day demands for the handling, shipping and marketing of fresh fish. One of the gentlemen who has been assigned to discuss this paper, Mr. Smith M. Wilson, has had considerable experience in the administration of this class of operation and I trust he will in his discussion give you some pertinent facts in relation thereto.

* Paper read before the 27th Annual Convention of the Pacific Coast Association of Port Authorities, September, 1940.

Cold Storage Facilities in Port Development—continued

Advantages

Rounding out the facilities of a Port terminal in order to give it a diversified tonnage in attracting vessels to a one-berth location, where they can load a large part or a full cargo without the expensive loss in ship's time of moving from one dock to another in the same Port, or to another Port of call.

An item that I left out in the paper is the matter of pilotage. In most ports, pilotage is compulsory and whenever you shift a vessel you have to add that factor to the cost of operation.

Protection to tributary farmers in allowing them to store their perishables at tidewater, where they may have the advantages of all classes of transportation with the least amount of handling, which, in turn, saves all intermediate trucking expense.

Vessels equipped with refrigerator space in any considerable quantity look for and patronise terminals having cold storage plants that can store and hold perishables for loading, as well as receive commodities that require immediate transfer from ship to cold rooms.

On many occasions it is found expedient by steamship agents to shut out shipments of fresh fruits that have already arrived at tidewater, due to overbooking and other causes; foresight of agents to these possibilities causes them to select terminals that have facilities for the proper care and temporary holding of such cargoes.

Various commodities in cold storage at tidewater necessarily attract other classes of freight in rounding out a ship's loading itinerary; in other words, the more diversified the commodities that are in storage at a port terminal, the more attractive the terminal is to vessels in nearly every trade and especially to those in foreign trade routes.

Fresh fruits of every character are just as readily distributed from tidewater plants as from those located in the interior and have the added advantages of access to all classes of transportation for the producer as well as the distributor, the same being true as to the reverse movement of inbound fruits, especially those handled by local inland water carriers.

Many producers of apples and pears, as well as brokers, who are in the foreign export business, find it advantageous to store at tidewater, rather than in inland cold storage plants by reason of the fact that they always have fruits on hand for spot shipments on cable orders, at the same time making connections with vessels that happen to be on berth when the orders come in. This situation also applies to shipments handled under letters of credit that are limited as to their time of duration, or that may be cancelled unless deliveries can be accomplished within a very short time.

Imports can be given quicker dispatch from the ship or storage space with the least amount of injurious handling at water from locations than to those plants further inland and with equal or better dispatch in later distributions.

Car-load trade can, in my opinion, be much better handled to and from cold storage facilities on port terminals than by those located in the centre of city congestion, where delays in rail and truck movements so often occur, to the detriment of the shippers and the goods.

There has developed quite recently and is still expanding the coastwise movement of perishables in refrigerated trucks and here again the tidewater storage lends itself most advantageously to this class of business. No delays are experienced in loading and the routes traversed, both in and out, are as a rule outside of the congested areas, speed being one of the controlling factors in this kind of operation.

Port authorities can and do have a very decided influence in the control of rates affecting many classes of cargo in terminal handling to and from vessels and I see no reason why they should not be in the cold storage business exerting the same influence in this direction, thereby being of further service to the farmers and taxpayers as a whole in their respective port districts. Surely it is an advantage for all to have an authority vested with the power to create facilities and then use them in the economical control of rates compatible with good business principles.

The financial advantage of a facility located at tidewater is one that should have the attention of any port official and in many cases where cold storage plants are presently a part of an Ocean Terminal the remuneration received from their operations is comparable to, or in excess of, any of their larger facilities.

Disadvantages

In presenting these disadvantages, I have done it more from the standpoint of operation rather than from the standpoint of the provision of a cold storage plant itself.

In many producing areas, particularly in the apple and pear sections of the Eastern part of the State of Washington, they have constructed large cold and air circulating storage plants that are capable of handling the greater portion of the crops grown under normal conditions and this naturally detracts from any volume that might otherwise be placed in tidewater storage; especially is this true in seasons of a short crop; furthermore these plants generally give, whether consistent or not, lower rates than the tidewater plant can meet and this is primarily due to lower wages paid at the interior points. Some of the inland plants are owned and operated by co-operative agencies which require their members to use the storage of that agency.

Many large and well equipped plants are located in the large populated sections of the central and eastern parts of the United States, who do, whether or not they should, give lower storage rates than the Pacific Coast plants can meet, due in a large extent to the immense volume of business they enjoy. One season—I think it was five years ago—the plants in the central part of the United States and on the Atlantic Coast cut the established storage rate on the Pacific Coast which is 15c. for 100 pounds per month) to 17½c. for 100 pounds per month. Naturally that put us in competition which we could not meet. This is notably true with respect to eggs and frozen foods, the latter commodities creating profits from a long carry, rather than from revenues derived from the initial freezing.

Competition from plants located in the vicinity of tidewater plants and doing mostly a so-called retail or consumer business, are detrimental to the port terminal facility in that they will endeavour to get storage business at low rates that is eventually to move by water transport and, in addition, absorb the costs of the extra handling required.

In other words, I refer there to a plant that might be located within the business section of a city. They will, in order to compete with the plant located at tidewater, absorb the extra cost of handling in the transportation to tidewater as a part of their rate.

Lack of refrigerator space in ships, especially with respect to those operating in our intercoastal service, where much potential business could be developed that is now moving all rail at high costs that could be eliminated to a large extent, thereby making a considerable saving to the consumers. This condition might well be taken up by our Port Authorities both on the Atlantic and Pacific Coasts in an endeavour to create more business for their terminals, with the resulting possibility of constructing more cold storage plants at tidewater.

War activities in Europe, and to some extent in the Orient, have almost completely stopped the movement of cargoes requiring refrigeration; however, this trade will, undoubtedly, come back if and when conditions again become normal.

Motor truck deliveries of fresh fruits are somewhat detrimental in that these consignments rarely move in complete lots on the same track, causing some expense in handling and checking of broken lots.

I recall during the apple season when large quantities of apples were moving to Europe, trucks would come in with a consignment that generally moves in carload lots, 756 boxes of apples to a car. Trucks would come with half of that amount or one-third of that amount and then they have to go over the scales in the process of their rules, state weighing scales, and I have known them to take out one box of apples off that truck because of being 49½ lbs. overload. When that shipment arrives at tidewater, we are short that one box and the steamship company will not accept the shipment until that box is ready for delivery. So you can see that it causes a lot of trouble.

Of concern to everyone in establishing a new or added facility at the present time, is the uncertainty and instability of wages paid labour with the added fear of numerous strikes occurring.

Conclusions

The provisions of cold storage plants at tidewater is unquestionably a part of and a function of Port Authorities and in my opinion has not received the attention it should in the development of our municipal terminal properties and they owe it to the public to provide such plants for the expeditious handling and storage of perishables.

It is just as important to provide facilities to handle all classes of cargo as it is to make the terminal easily accessible and adequate for all classes of transportation.

In determining the site for these plants importance must be given to the free and easy accessibility to railway cars and motor trucks, in no case place them where they will be limited or restricted to tracks and roadways; likewise so place them as to allow for a continuous movement of goods directly between the cold storage house and ship's tackle.

The control of and the actual operation of these plants, when owned by a municipality, should, in my judgment, remain in such Authorities' hands and not be leased to outside companies or individuals, as so many matters arise from time to time affecting operations and policies that cannot be foreseen throughout a long lease period.

The solicitation of business for tidewater cold storages that are owned and operated by a Port Authority, should, I think, be carried on throughout the outlying territory that is tributary to that port rather than attempting to secure purely local business

Cold Storage Facilities in Port Development
(continued)

that will re-act against the privately owned plant that is located away from the waterfront in the city where the port carries on its operations, always keeping in mind the desirability of carload trade as against small and diversified local consignments.

The present trend of Government regulation of all classes of transportation, including the terminal operators who are a connecting link in the transportation chain, would take in cold storage warehouses and place them in an embarrassing position in that they could not compete with inland plants, not coming under regulation, this must be carefully watched and if such regulation does come about, make strenuous efforts to have cold storage warehouses, that are a part of an ocean terminal excluded from regulation.

Taxpayers, who supply in varying extent the means to establish and carry on municipal port development, are entitled to as many various classes of facilities as are possible, compatible with funds available, including cold storage.

(To be continued)

Duties of Port Directors and Shipping Representatives

Statement by Ministry of War Transport

The following announcement has been issued by the Director-General of the Ministry of War Transport:

Arrangements have already been made at headquarters to unify efforts to secure the quickest turnround of ships and the Minister of War Transport has now approved the following arrangements at the ports themselves.

In those ports where a Regional Port Director is appointed, he is responsible for all the work arising out of the functions and duties of the Ministry relating to the operation of the ports within his region, and for these purposes is the Minister's chief executive officer.

In matters relating to the loading and discharging of ships, he will have the assistance of the Shipping Representatives at the ports within the regions and, where a Regional Shipping Representative is appointed, the latter will act as Shipping Adviser to the Regional Port Director. The Regional Shipping Representatives, where appointed, and the Shipping Representatives will continue to deal, on behalf of the Minister, with such matters as the supervision of ships' managers and agents and with questions (other than loading and discharging) which affect ships in port, e.g., crew problems, progress of repairs and arrangements with the Naval Authorities.

The Regional appointments already made are as follows:——

Mersey Ports.—Regional Port Director: Mr. J. Gibson Jarvie; Regional Shipping Representative: Mr. J. R. Hobhouse.

Scottish Ports.—Regional Port Director: Mr. R. Letch. (The appointment of Mr. Letch has been extended to cover all Scottish ports.)

Regional Shipping Representatives: West Coast, Mr. J. C. Denholm. East Coast, Mr. R. F. Scovell.

Bristol Channel Ports.—Regional Port Director, Mr. R. Hugh Roberts; Regional Shipping Representative, Sir William Reardon-Smith.

In addition to the above the Minister has appointed Mr. B. Eliot Common to be Regional Port Director for the North-Eastern Region of England which extends from the Tweed to the Tees.

The work of the Coasting and Short Sea Shipping Control Committees is unaffected by these arrangements.

The Dredger "Fu-Shing"

In connection with the presentation by Dr. Herbert Chatley, M.Inst.C.E., to the Junior Institution of Engineers of a fine marine painting by a German artist, Mr. R. Schmidt, of Hamburg, of the drag-suction dredger *Fu-Shing*, which was constructed for the Whangpoo Conservancy Board under Dr. Chatley's supervision, the following particulars of the vessel are given in the Journal of the Institution:—

The *Fu-Shing* is a notable vessel, being the largest drag-suction vessel ever constructed, and the second largest dredger of any type, her dimensions being exceeded only by those of the sand-pump dredger *Leviathan*, built at Birkenhead in 1909 for the Mersey Docks and Harbour Board. She was designed to dredge the bar of the Yangtse River, at its junction with the Whangpoo, in pursuance of a scheme prepared in 1921 by Lieut.-Col. von Heidenstam, M.Inst.C.E., then Engineer-in-Chief of the Whangpoo Conservancy Board, but not begun until 1935, when Dr. Chatley held that position. The builders were the old-established firm of F. Schichau G.m.b.H. The ship was launched on April 2nd, 1938, and successfully carried out the builders' trials, but was then laid up at the builder's yard pending some clarification of the situation in the Far East, as it was obvious that, had she proceeded at once to the Yangtse, her capture by the Japanese was certain. However, the position did not improve, and, so far as is known, she is still in the Baltic. The name *Fu-Shing*, according to Dr. Chatley, means "Regeneration." Those who have watched the long struggle of China against the Japanese invaders will doubtless hope that it may prove prophetic.

The principal dimensions of the *Fu-Shing* are as follows:—Length, 410-ft. 6-in. overall, and 400-ft. between perpendiculars; moulded breadth and depth, 62-ft. 5-in. and 28-ft. 6-in. respectively; gross tonnage, 5,710; deadweight capacity at 18-ft. draught, 4,180 tons (maximum draught=22-ft.); speed 11½ knots. The hopper holds 3,820 cu. yards to main-deck level, or rather more than 4,000 tons of the mixture of water and Yangtse mud that she is designed to handle. The reciprocating main engines drive twin screws, and each develops 2,250 h.p. at 140 r.p.m. The pumping engine is similar in design, except that it is not reversible, and develops 2,500 h.p. at 150 r.p.m. The dredging pump is of the side-suction centrifugal type, with an impeller 9-ft. in diameter, and delivers through a discharge pipe 1 metre in diameter. There are four Babcock & Wilcox straight-tube marine boilers, with superposed superheaters and tubular air heaters, and fired by mechanical stokers. A detailed description of the vessel and her machinery, from which the above particulars have been abstracted, appeared in *Engineering*, Vol. 146, pp. 495, 577 and 638 (1938).

Notable Port Personalities

XIII.—Mr. W. J. Thomas

Mr. William John Thomas, Chief Docks Manager of the Great Western Railway Company, was born in 1884 and after completing an apprenticeship in mechanical and marine engineerng, he served at sea and obtained a first-class Board of Trade Engineer's Certificate.

Mr. W. J. THOMAS.

In 1906, he joined the Barry Graving Dock Company as assistant to the General Manager. Two years later he was appointed Assistant Superintendent of the Hain Steampship Company's fleet of 40 steamers. Subsequently he became Chief Superintendent, but resigned in 1919 to enter business on his own account.

He joined the Great Western Railway Company in 1924, as Assistant Marine Superintendent, and when, in 1927, the Marine Department was amalgamated with the Chief Dock Manager's Department, he was appointed Chief Marine Assistant to the Chief Docks Manager. In 1929, he became Marine Manager, and in 1935, Deputy Chief Docks Manager, finally succeeding the late Mr. Charles S. Page, in the senior position in January, 1936.

As Chief Docks Manager, he is responsible for the administration of the Company's docks at Cardiff, Swansea, Newport, Barry, Port Talbot, Penarth and Plymouth (Millbay). He also has charge of the Company's fleet of passenger and cargo steamers.

Mr. Thomas is a Fellow of the Society of Consulting Engineers and Marine Surveyors.

Gates for Lock and Dock Entrances

An Article for Students and Junior Engineers

By STANLEY C. BAILEY, Assoc.M.Inst.C.E., F.G.S.

General Observations

GATES for closing the entrance of Locks, Dry Docks and Basins may be used under almost any conditions of tide. They have the advantage over Ship and Sliding Caissons of being operated rapidly, and for entrances of from 80 to 100 ft. wide, they can be opened or closed in about 1½ minutes, while a sliding caisson would require 4 minutes. With the exception of Ship Caissons they form the most economical method of closing an entrance, and are used for entrances up to 130 ft. wide.

On the other hand, with the exception of timber-built gates, they are not easily repaired in sitû if damaged. Gates made of greenheart timber will not float, and steel ones with single skin plating require to be lifted off the lower pintle by means of cranes or pontoons, and thus conveyed to a dry dock or slipway for repairs. Steel gates with double skin plating and having air and water chambers, are made buoyant by closing the water chambers, pumping the water out, and ballasting with water or cast iron as required in the lower chambers. They may then be floated out almost vertically on a rising tide off the lower pintle, and towed away for repairs, being afterwards refixed in sitû on a falling tide.

Pitch pine and oak gates can similarly be floated off the lower pintle, and laid flat on the water with the assistance of cranes, and thus floated away.

Gates made of greenheart are best removed by means of a floating crane or pontoons.

Greenheart timber gates are more expensive than steel ones, but will last longer than the latter, their life being from 50 to 80 years. Oak and creosoted pitch pine gates will also last a considerable time if not attacked by marine mollusca.

Types of Gates

Various types of gates have been constructed, according to the circumstances, exigencies of the site and tides and financial considerations.

In many cases, especially for small locks of canals, they are constructed of timber baulks, with a single skin of planks, while wrought iron and steel gates are formed of horizontal and vertical framing with, in some cases, single outside skin plating; but most of these gates have cellular framing with air and water chambers, and with plating on both sides.

In small lock entrances a single leaf pivoted gate is sometimes used, but in most cases there are two leaves which mitre together in plan, at the apex of a triangle, whose base is the width of the entrance, and versed sine usually 1/4 to 1/6 of the width, although some have been made with a rise of 1/9 to 1/10 of the span. A rise of 1/5 to 1/6 of the span is the most economical proportiõn, for the longer the rise given, the greater is the pressure on the gate, but the horizontal thrust is reduced, for instance in the case of a pair of cambered gates for a dock entrance 120 ft. wide, and with 45 ft. depth of water at H.W.S.T. the total water pressure will be $= \frac{45\times45}{2\times35} \times 1 = 28.92$, say 29 tons per lin. ft. If the rise is 1/4 of the span, or 30 ft., the total pressure on one leaf will be 29×70 ft.=2,030 tons or 4,060 tons on two leaves, and the horizontal thrust $= \frac{W.L.}{8.V} = \frac{4060\times120}{8\times30} = 2{,}030$ tons, and the inclined axis thrust will amount to 2,290 tons. Should the rise be made 1/8 of the span or 15 ft. the pressure will be 29×65′=1,885 tons per leaf, or 3,770 tons on two leaves, and the horizontal thrust $= \frac{3770\times120'}{8\times15'} = 3{,}770$ tons, while the axis thrust will be 3,900 tons.

The width or thickness of flat-sided timber and steel gates is usually made 1/12 to 1/13 of the length of the leaf, and this is the same for timber gates with cambered outer faces, but in steel cellular gates with air and water chambers, and having curved outer faces, the width is generally made 1/6 to 1/10 of the length of the leaf. When the width exceeds 1/7 of the leaf length, there will be too much buoyancy, which is objectionable. Small lock gates made of timber have flat sides, but most of the larger ones have cambered outer faces, while steel gates have usually cambered outer sides, but in most modern gates both sides are flat, with curves or a flat taper on the outside near each end to the mitre and heel posts.

Several have been constructed in the form of an arch, with curved inside and outside faces, but this entails expensive work at the clapping cill, and in the construction of the gate. In cases where the entrances to locks and docks are on the skew to the walls of a basin or river, the leaves of the gates have been made of unequal lengths, so that they can be housed in the entrance walls, and so reduce the length of the entrance, and increase that of the lock or dock.

Another type of gate used at the Port of Stockholm consists of two leaves with flat faces on the lock side, while the outer faces form quadrants of circles stuck from the pivots. When these gates are opened, the quadrants pass into deep recesses in the entrance walls. There are gates of a very similar type with single skins on the Sodertalje Canal in Sweden.

In all pivoted heel post gates recesses are necessary in the entrance walls to house the gates, including the fenders on them, so that they may lie flush when opened with the faces of the entrance walls.

The Edward Box falling gate consists of a single leaf with flat sides pivoted at the cill level, the width or thickness of the gate being 1/13 of the span. It is formed of steel framing with horizontal ribs, and plating on each side, with provision for air and water chambers.

The trunnions at each end of the gate at cill level turn in plummer blocks, and the hollow quoin of the cill is of cast iron 9 in. radius and 1⅛ in. thick, into which fits the greenheart timber cill of the gate.

The vertical greenheart square timber clapping posts at each end of the gate fit into recesses in the entrance walls, which are faced with fine axed granite.

An hydraulic buffer press is provided at the top of each entrance wall opposite the heads of the clapping timber; and also locking arrangements, consisting of steel-wedged shaped blocks pivoted at the coping level, which drop into suitable brackets on the gate. This form of gate involves the construction of an outer entrance several feet deeper than is required for ordinary and pivoted gates, so that it may lie flush with the cill level when submerged, where it rests on two timber pile heads, or on concrete blocks capped with wood.

In some cases the gates fall into pits, and arrangements are made to remove the sand and mud that may collect by means of flushing culverts in the gates, or by a system of hydraulic jets operated by pumps.

As gates are too narrow for road traffic, a swing or bascule bridge has had to be provided across the entrance in several instances, in such cases a ship or sliding caisson in lieu of gates would be more economical.

Most gates are fitted with a gangway for foot traffic, consisting of timber planks laid either transversely on beams supported on steel frames about 6 ft. apart on top of the gates, or on longitudinal planks bolted to the frames, a few of which are braced together longitudinally.

The gangways are provided with fixed galvanised handrail stanchions of forged steel or angle steel, and with tube handrails, or galvanised short link chains. As gates are subject to static loads, the side plates may be either electric or acetylene welded; this will save about 10 per cent. of the weight due to riveted plates.

Weights of Gates

In the following particulars the weights of gates are given in cwts. per square foot of gate area from coping to cill level. A greenheart timber gate for a small lock entrance 30 ft. wide and 20 ft. high weighs about 0.54 cwts. sq. ft., and if of oak about 0.406 cwts.

The steelwork in pintles, straps, tie bars and bolts will weigh about 11.5 lbs. per sq. ft., of which the bolts weigh 4.5 lbs. sq. ft. A greenheart gate for an entrance 85 ft. wide, one leaf of which is 47 ft. 6 in. long and 41 ft. high, would weigh about 1.95 cwts. sq. ft.; an oak gate 1.33 cwts., and pitch pine 1.15 cwts. sq. ft. Of these figures the total steelwork would weigh 37 lbs. sq. ft., of which the weight of the bolts would be 23 lbs. sq. ft. As regards flat steel gates with single outer skins, the weight varies from 0.625 cwts. to 0.945 cwts. sq. ft., and if of the cellular type with double skins, 0.8 to 1.1 cwts. sq. ft.

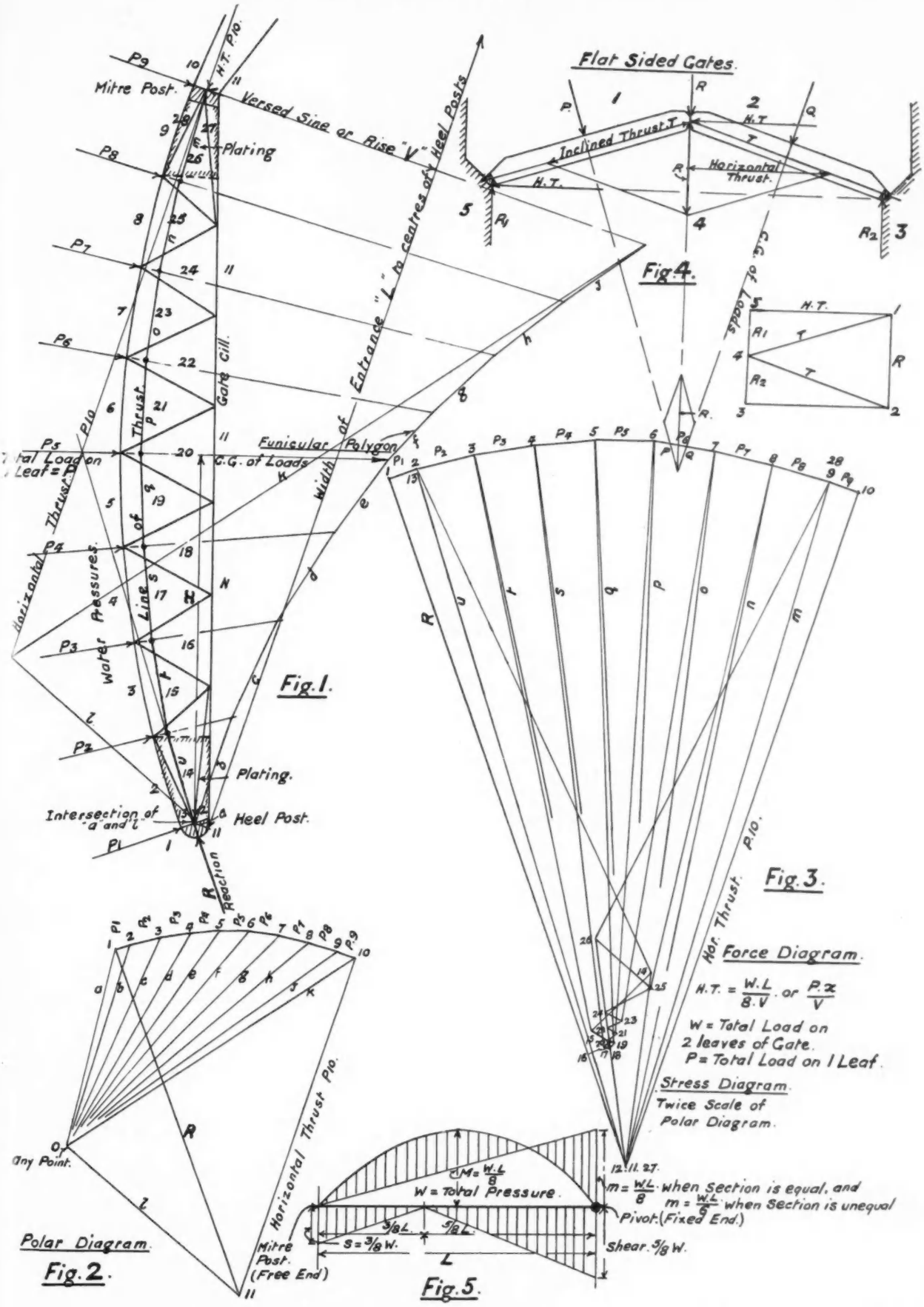
Arched gates with single skins weigh 0.554 cwts., and with double skin plating 0.73 cwts. sq. ft.

Steel gates of the cellular type with air and water chambers, and having one cambered and one flat side, vary in weight from 0.784 cwts. to 2.27 cwts. sq. ft.

The average of 10 light gates is 1.086 cwts., and of 3 heavy ones is 2.202 cwts. sq. ft.

Cambered gates having 1 in. side plates at bottom, diminishing to ⅜ in. at top, weigh 1.353 cwts. per sq. ft. for single skins, and 1.65 cwts. sq. ft. for double skins; while those with ⅝ in.

Gates for Lock and Dock Entrances—continued



lower side plates and 7/16 in. thickness for the remainder weigh about 0.945 cwts. for single skins, and 1.12 cwts. sq. ft. for double side plating.

A large gate leaf of greenheart 47 ft. 6 in. × 41 ft. high for an entrance 85 ft. wide will weigh about 190 tons, while steel cellular gates range from 100 tons per leaf for a 75 ft. wide entrance, 56 ft. deep to 496 tons for a 130 ft. entrance 59 ft. deep from coping to cill, and to so much as 660 tons for an entrance 110 ft. wide, and 76 ft. deep, as at the Panama Canal locks.

Construction of Gates

Timber-built gates for small locks are usually constructed of either oak or creosoted pitch pine, mortice and tenon jointed framing 12in. to 14in. square, with horizontal ribs, and vertical

Gates for Lock and Dock Entrances—continued

planking on the high water side, from 2 to 4 inches thick, according to the spacing of the ribs.

The edges of the planks are tongued and grooved or V jointed, the planks being spiked to the walings by galvanised steel spikes.

The joints of the framing and ribs are bound together by mild steel straps 3in. x ¾in. thick on each side ; and 1in. dia. galvanised bolts.

On the side of the gate which is not planked, a strong diagonal tie bar from the top of the pivot end of the gate to the foot of the mitre post is fixed, and fitted with gib and cotter for tightening up, or a round rod with a right and left handed screwed union may be used.

The timber heel posts have a radius of from 6ins. to 8ins. and the gates are coated with coal gas tar, or bitumen applied hot. Large wooden gates are generally made of Demarara greenheart baulks 14in. to 16in. square in two thicknesses at the bottom for about one-third of the height, and for the remainder the ribs are in groups of 6 or 4, leaving spaces of 3 to 4ft. between, which are filled in on the cambered high-water face with vertical tongued and grooved planks about 3 to 4 ins. thick. The heel posts have a radius of from 9 to 12 ins., and there are a few vertical posts between the heel and mitre posts. A diagonal tie-bar from 6in. by ¾in. to 7in. by 1in. is fixed on the flat side of the gate having an eye-bar and pin at the bottom of the mitre post, and a round bar forged on with screw and nut at the top of the heel post, attached to a steel bucket.

The bolts vary from 1⅜ ins. to 1⅞ ins. dia., according to their length, and are fitted with steel washers 3 to 4 ins. square and ½in. thick.

Some of these large gates are fitted with a roller near the foot of the mitre post with a 9in. x 9in. or 12in. x 12in. vertical timber spear from the roller bearing block pivoted casting, to a casting near the top of the gate, the roller and the radial roller path should be of cast steel.

A cast iron or 7 lbs. per sq. ft. lead cap is fixed to the top and bottom of the mitre post, and on top of the heel post. Gates made of Australian Karri pine have been attacked by marine mollusca, but greenheart is not so readily destroyed by them.

Steel gates of the cellular type, flat on one side, and cambered on the other, are constructed of horizontal and vertical framing, some of the horizontal frames are decked to form air and water chambers, while others are braced horizontally, two or three vertical bulkheads are also formed. and vertical frames have cross bracing to prevent distortion.

At the heel and mitre post ends, each horizontal frame is plated in plan for several feet to stiffen the ends.

The skin plates on each side vary from about 1 in. thick at the bottom to ⅜in. at the top, according to the depth of water, and spacing of the horizontal frames, and are lapped over one another at horizontal joints, and butt together at vertical joints, which are fitted with outside cover plates, while all joints are caulked. The side plating will weigh about 62% more than the ribs. Gates and decking have been constructed with ⅜in. plates in the lower tier, and 7/16in. plates in the upper ones, by suitably spacing the horizontal frames, so that there is equal pressure on the plates in each tier, but this has only a limited application, as the ribs will be too close together in deep gates. Sometimes the thickness of the plates is given in twentieths of an inch as in shipwork. The tension on the steelwork should not exceed 6.5 tons per square inch, and the end compression 3.5 tons sq. in. Some gates are built with an air chamber throughout, in which case there will be considerable uplift at H.W.S.T., which can be reduced by the insertion of water ballast tanks.

Others with a central air chamber and tidal water chambers above and below will have no uplift, but a heavy dead weight, while those having a lower air chamber, with a tidal water compartment above will also have no uplift, and the dead weight will be reduced to a minimum, this latter is the most suitable arrangement. Too much uplift at extraordinary high tides has been the cause of failures of several lock and dock gates.

The vertical bulkheads are fitted with sliding doors and valves. water being admitted to the tidal chambers by exterior valves or openings on one side of the gate, these valves are worked from the top deck.

In some cases the end chambers of the air chamber are used as water ballast tanks.

Force pumps which are either hand or electrically driven are installed in the air chamber, and hand worked pumps in the upper and lower water chambers are operated from the top deck of the gate. Trunks about 2ft. 6in. diar. or square, for access to the air chamber are fixed between the top deck of the gate below the platform, and the upper deck of the chamber, and there are sometimes also trunks from the top deck to the lower deck of the chamber, so that divers may reach the lower water chamber. All trunks are fitted with watertight covers ; also the openings in the top deck of the gate for access to the upper water chamber, with ladders to the top deck of the air chamber. The trunks are provided with step irons 9 ins. apart, and also the rungs of ladders between the upper and lower decks of the air chamber under the trunks. Air vent pipes 2 to 3 ins. in diameter should be fixed to all air and water chambers, and carried up above the top deck of the gate, terminating in an inverted U bend.

Strong lifting eyes of forged or cast steel are usually fixed to the top of the gate near each end and on each side, being bolted or riveted to the plating strengthened by additional plates and channels on the inside.

In gates with single skin plating the heel posts have radii of from 7½ to 9 ins., and in large gates with double skin plates, the radii varies from 12 to 16.5 ins. This is done to allow sufficient space inside for fixing the bolts and for efficient riveting, and to reduce the pressure per sq. ft. on the timber. All bolts connecting timber to the steelwork should be a driving fit, and supplied with washers, and also grummets or rings of tarred hemp.

Between the timber of the posts and cill, and the steelwork, a layer of bitumen sheeting or tarred felt should be placed, this will make the joints watertight, and assist in the prevention of rust in the steel.

In several instances the hollow quoins and bearing faces of the clapping cills have been made of greenheart timber in lieu of fine axed and carborundum rubbed granite, it is less expensive than the latter, more easily repaired, and is quite satisfactory. The granite quoins and cill faces are sometimes polished, but experience has shown that this refinement is not necessary. The contact area of the mitre post should be reduced to compel the line of thrust to pass through a limited area.

The use of timber in the heel and mitre posts of gates has the advantage that the timber swells slightly and thus assists in keeping the meeting surface watertight, but in the gates of the Panama Canal locks the centres of the top and bottom pintles are fixed to each gate leaf 9 inches from the end of the gate, in which is attached a steel casting from the top to the bottom, having a projecting centre web with a jaw holding a nickel steel convex bearing face 13 inches from the gate end, which bears against a concave nickel steel rubbing strip fixed to a steel casting embedded in the wall to form the quoin. When the gates are opened, the casting on the gate swings out clear of the quoin. Similar fittings to those on the heel post end are fitted to form the mitre posts, thus reducing the friction when operating the gates.

Sluices

In cases where there are no culverts and penstocks in the walls of the entrance for levelling a lock or for filling a dock with water, then sluices with cast iron frames, doors, and gunmetal meeting faces are fitted to the gates on the outside of the flat face, and are operated from the platforms of the gates. The sluices are from 2 to 4 ft. square, with a sliding vertical door attached to a vertical steel rod about 2 inches dia., at the upper end of which is a long rack bar about 3 inches wide which engages with a 6 in. dia. pinion enclosed in a cast iron or steel boxed-in frame on the gate platform.

On the opposite side of the pinion there is another vertical rack to which a balance weight is suspended to reduce the power required. On the pinion shaft is a 2ft. diar. toothed wheel engaging with a 4 in. dia. pinion, on the shaft of which is fixed a handwheel 2 ft. 6 in. dia.

In gates of the cellular type the water is passed through the gates in square or circular steel culverts, the sluices being operated by vertical hydraulic cylinders about 7 in. dia. fixed on the backs of the gates above H.W.S.T. level.

Pivots and Anchorages

The top pintle or pivot of gates is usually of forged or cast steel with a turned surface, with a fan shaped flange bolted to the top of the gate, and having ribs underneath which are sunk in holes in the plating of the gate.

The pivot is held by a strong flat steel band or gudgeon passing round the pivot and fixed by a gib and cotter to flanges on a fan shaped steel casting bolted down to the entrance wall on each side of the lock. The anchor bolts radiate from flanges on the gudgeon casting, and are carried down well into the walls, being provided with screwed unions and anchor plates. In some large gates a phosphor bronze or immadium bush is fitted to the gate pivot, or cast steel vertical friction rollers, from 6 to 9 ins. long and 3 ins. diar. are inserted between the gudgeon and the pivot, the gudgeon being of cast steel with a hole to fit over the pivot, and supplied with a cover plate having oiling holes.

The top pivot and the foot casting for the bottom pivot are sometimes made hollow when of large sizes.

The bottom pintle of forged or annealed cast steel is cup shaped and is fixed to the gate in a similar manner to the top pintle. The cup should not be too shallow or there will be a tendency in some cases for it to rise off its bearing, which is a boss or pivot with a convex or hemispherical head with a flange countersunk into the granite or concrete of the entrance and bolted down.

(To be continued)

(*Note:* For convenience of arrangement, Figs. 1 to 5, though not referred to herein, are included with this issue; they will be described and explained with other diagrams in the next instalment of the article).

Concrete in Sea Water

Some Experiences at New York Harbour

The following article, reproduced by permission from *Concrete and Constructional Engineering*, forms an interesting sequel to the Paper on the subject by Mr. Homer Hadley, which appeared in the June issue of this Journal with Discussion in the July issue.

Nineteen concrete structures in sea water were recently examined at New York in order to determine the best practice to adopt in the construction of the East River Drive. The structures are in the Hudson, Harlem and East Rivers and in Jamaica Bay and were built between 1902 and 1932.

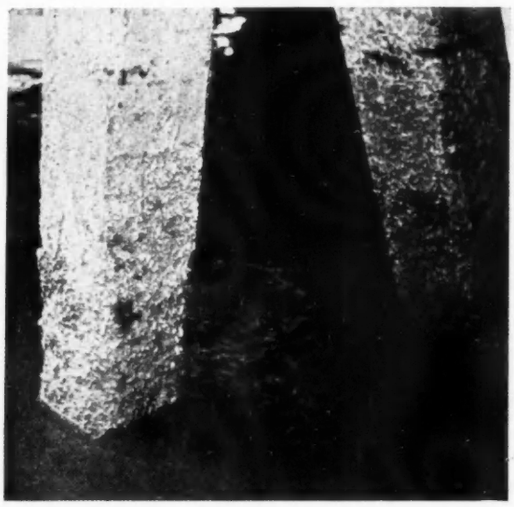


Fig. 1. Piles Disintegrated after Ten Years' Exposure.

Some of the structures showed serious disintegration, but in each case the effects could be attributed to violation of good construction or design practices. Some of the oldest have withstood the action better than some of the newer structures under identical conditions of exposure, the differences in performance usually being due to differences in construction practice. The investigation showed that concrete which can resist disintegration in sea water can be and has been secured in New York Harbour. Dense concrete, ample cover over the reinforcement, good workmanship, and protection of the concrete in the tidal range with some form of facing to prevent physical and mechanical damage seem to constitute the necessary requirements.

As a result of the investigation in the East River Drive project the materials were carefully selected; the concrete mix was determined by trial to produce high density and strength; 6¼ bags of cement were used in each yard of concrete; the sand was well graded and required to contain from 3 per cent. to 7 per cent. of fines passing a 100-mesh screen; all steel was covered with at least 2½-in. of concrete; strict inspection was maintained; bulkheads within the tidal range were protected with granite; and timber forms were in most cases retained on the undersides of slabs. As a further precaution against disintegration sulphate-resistant cement was used.

In the inspection of the harbour structures it was noted that on bulkheads there was characteristic disintegration at the bottom of the walls where the concrete rested on the timber cribbing. It is believed that this was caused by the use of leaky forms and mixes that permitted accumulation of coarse aggregates at these points. It was noted that, contrary to general opinion, disintegration above the high-water line was not very prevalent and not nearly so severe as had been anticipated, even in cases where heavy wave action occurred or where the concrete was of relatively poor quality. The injurious effects of abrasion from floating debris and ice and the battering of docking vessels were frequently apparent and indicated the need for some form of protection, either wood or masonry facings, within the tidal range and on the outside faces of docks. Where decks had been subjected to alternate wetting and drying by wave action they exhibited good resistance when not subjected to prolonged wetting and consequent absorption of water, as in tidal action.

While it was difficult to examine the submerged concrete in most instances, the waters in Jamaica Bay and portions of the East River were clear enough to permit inspection for some distance below the water line on a few of the structures. It was found that very little disintegration occurred below low water even where the concrete was of such poor quality that severe disintegration had taken place within the tidal range.

Examination of Piles

The contrasting performance of pre-cast piles on the 46th Street and 107th Street Piers in the East River (Figs. 1 and 2) shows the need for exceptional care in workmanship on such relatively thin sections containing considerable reinforcement. On both structures the piles are 14-in. square; they are 62-ft. to 74-ft. long on the 46th Street Pier, and 55-ft. to 65-ft. on the 107th Street Pier. The same specifications were used on both structures. The 46th Street Pier was started in October, 1931, and the 107th Street Pier in January, 1932. Piles on the 46th Street Pier show considerable disintegration within the tidal range and the concrete appears very porous. On the other hand, the piles in the 107th Street Pier are in excellent condition, the surfaces still showing the marks of the rough form timber. It is of interest to note that surface scaling had started on the piles of the 46th Street structure when an examination was made in 1935, only three years after the piles were driven.

Among the structures examined was the Jamaica Bay causeway (Fig. 3), construction of which began in January, 1922. The total length of the structure is 23,505-ft., of which 8,785-ft. is of reinforced concrete pile and deck construction. The deck consists of a 36-ft. roadway with 16-ft. of footpath, supported on 2,200 24-in. square piles in trestles spaced at 24-ft. centres with expansion joints every 72-ft. The height of decking above mean high water varies from 9-ft. to 31-ft. The specifications required sulphate-resistant cement, 3,000 lb. concrete at 28 days, continuous wet curing for at least 60 days before driving piles, and a coat of bituminous paint applied before driving to the portion of the pile situated between 2-ft. below low water and 3-ft. above high water. After driving, this portion was further protected by creosoted timber sheeting strapped around the pile.

Examination of the piles showed that all were in excellent condition. At one or two places where the timber protective sheeting had fallen away, due to corrosion of the metal straps, the concrete within the tidal range was examined. Here also the concrete was in excellent condition, showing no signs of disintegration. The care used in its construction and the precautions taken to protect vulnerable spots are being repaid on this structure after 17 years. While sulphate-resisting cement was used on this project, so far as is known normal Portland cement was used on all other structures examined.

Miscellaneous Structures

The bulkhead wall from 77th to 78th Streets in the East River is constructed of large granite blocks set upon rock. The surface of the rock was very irregular, and in order to level it concrete in bags was placed on the surface and the granite blocks were then set on the cushion of bagged concrete. Examination disclosed that the concrete is in excellent condition and so dense and tough that a piece could not be dislodged from an overhanging section with a 5 lb. sledge hammer and heavy chisel. While the mixture used was leaner than would be generally used for sea water exposure to-day, it is very likely that it had a low water cement ratio since stiff concrete is usually required for placing in bags. The concrete had been in place for thirty-two years at the time of inspection, and there was every indication that it would serve its purpose indefinitely.

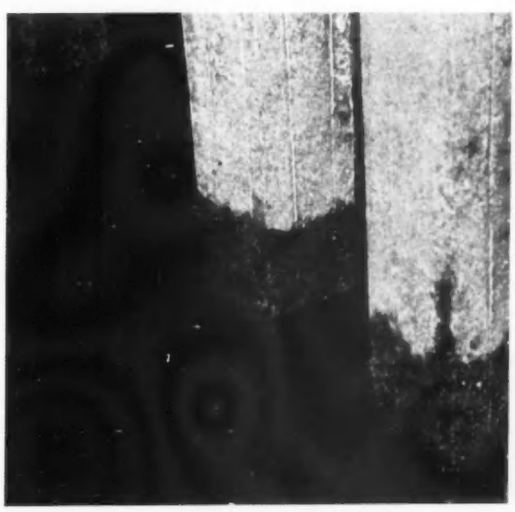


Fig. 2. Sound Piles after Ten Years' Exposure.

A bascule bridge over the Dutch Kills was built by the Long Island Railroad in 1909. There are four plain concrete footings about 5-ft. in diameter under the fulcrum of the span. These were protected by 6-in. by 2-in. timber sheeting extending from the bottom of the creek to within 6-in. of the top of the footing.

Concrete in Sea Water—continued

The tops of these footings are only a few inches above high water. Inspection of one of these footings from which the sheeting had been removed showed that, while there was some disintegration on the surface, the concrete is in excellent condition. Considering the age of the concrete and the characteristics of the water to which it has been subjected, its resistance to disintegration has been exceptionally good. Newtown Creek, to which Dutch Kills is a tributary, is practically an open sewer, carrying not only domestic sewage but also high concentrations of industrial wastes. The water is highly acid. Such conditions are highly corrosive to concrete, yet the concrete, protected by only a timber sheeting, has stood up exceptionally well for over thirty years.

A bulkhead consisting of pre-cast blocks, each containing 7 cu. yds. of concrete, was constructed at 207th Street in the Harlem River in 1927. A well-designed mix containing 5 gallons of water per sack of cement and giving a 2-in. slump concrete was used. The concrete is in excellent condition after twelve years' exposure. No signs were discovered of incipient disintegration at the joints between the blocks.

Fig. 3. Piles in Good Condition after Eighteen Years' Exposure.

The whole investigation proved that, in spite of the severe disintegration noted in some of the structures, concrete can and does resist the ravages of sea water over long periods of time when it is properly designed, mixed, placed, cured, and subsequently protected.

Review

The Port of New York, published and issued gratis by the Port of New York Authority, New York City, U.S.A.

This brochure of 95 pages, copiously illustrated with maps, charts and diagrams, is stated to have been designed, compiled and written within the staff of the Port of New York Authority. It is an admirable exposition of the functions, services and achievements of the Authority and will be welcomed, not only for the wealth of its information, but also for attractiveness of its artistic production.

Commencing with an explanatory Foreword over the names of all the members of the body, it goes on to give a Saga of the Port, setting out the origin and development of its present commercial influence and prosperity. Next, under the heading of "Port of Many Ports," covering 650 miles of water front, it describes in detail each of these component sections of its entity. The following extract will give some idea of the tremendous scope of the local activities.

"The Port of Many Ports is a district of fifteen hundred square miles, embracing parts of two states and several hundred municipalities and other civil sub-divisions. On the New York side are Brooklyn, Bronx, Queens, Richmond and Manhattan. On the west banks of the Hudson are numerous New Jersey deep-water ports, which include Newark, Kearney, Elizabeth, Bayonne, Perth Amboy, Hoboken, Jersey City, Edgewater and Weehawken.

"Plying in and out of these ports, any day, may be found a suitable cross-section of the world's merchant fleet. On the Hudson River, super-liners and stream-lined express passenger-cargo ships ride proudly in their berths. On the Brooklyn water front, freighters from Capetown and Bombay, from Alexandria and the River Plate disgorge cargoes of coffee and hemp, manganese, chrome ore and mahogany, Egyptian cotton and Brazil nuts. Coastwise colliers steam up the East River with fuel for huge power plants. Cargoes of lumber from the west coast move up Newark Bay. Steam up, ready to sail, from Stapleton, are British freighters, their holds filled with vital loads of airplane parts, tractors and machine tools. Into the tanks of a soap factory, on the Kill van Kull, a whaler from the Antarctic discharges the whale oil processed by the ship's own machinery. At Gowanus Bay wheat pours from the state grain elevator into the holds of waiting ships.

"Through the Port of New York each year moves the titanic total of a hundred and twenty million tons of commerce, valued at ten billions of dollars. This stupendous traffic is moved with efficiency and dispatch."

In addition to its purely commercial and navigational interests, the Port of New York Authority is charged with the responsibility of promoting and maintaining avenues for internal traffic through and to and from the port. Directly or indirectly it has constructed and controls the George Washington Bridge and the Lincoln and Holland Tunnels connecting the two banks of the Hudson River, the Triborough Bridge across East River and a number of other bridges over various river channels and waterways within the port area. The number of new vehicular crossings constructed since the formation of the Authority in 1920 is 26. In tabulating all these facilities, the Authority disclaims credit for the whole of the progress of the port. "Many agencies —federal, state and local—are efficiently performing essential governmental functions in the Port of New York. These are the administrations of the two states themselves and of the several hundred municipalities within the Port of New York district. Transportation companies, industries, countless anonymous workers on the water front carry on the day-to-day work of the port and contribute to its development."

The brochure is a very fine record of work admirably conceived and energetically carried through. It undoubtedly achieves its purpose of pointing the way towards ever-broadening horizons for the Port of New York and the nation it stands ready to serve.

The Port Authority at present is constituted as follows:—Chairman, Frank C. Ferguson; Vice-Chairman, Howard S. Cullman; Commissioners: A. J. Shamberg, John J. Pulleyn, George de B. Keim, Rudolph Reimer, Joseph M. Bryne, Jr., Charles S. Whitman, John Borg, Frank J. Taylor, Raymond M. Greer and Frank Dorsey.

Dundee Harbour Trust

Retirement of Engineer and General Manager

Mr. J. Hannay Thompson, O.B.E., M.Inst.C.E., Engineer and General Manager to the Dundee Harbour Trust, retired on superannuation on July 14th. He had held the joint posts since 1909, prior to which he was Engineer from 1901.

Mr. Thompson was born at Newcastle in 1869 and was educated at Trinity College, Harrogate, and the College of Science (now Armstrong College), Durham University. He then joined his father in dock and harbour works at Newcastle, Blyth, Sunderland, Hartlepool and Bilbao. In 1895, following a short time with the Wallsend Slipway Company, he became associated with the firm of Sir John Coode, Son and Matthews, Consulting Engineers, of Westminster, for whom he carried out an important survey of the River Avon at Bath, as well as Admiralty work at Dover.

During the 40 years of his service with the Dundee Harbour Trustees, he effected a number of port improvements and extensions, principally increasing the quayage accommodation. He took great interest in the use and development of reinforced concrete for riverside construction and the King George V Wharf with its ancillary shed accommodation is a memorial of his enterprise in this direction.

Mr. Thompson's services were employed by the Government during the last war in connection with the military port scheme at Richborough. He also took a real interest in the promotion of technical education, especially in cultivating Franco-British co-operation in this field.

Mr. Norman Alistair Matheson has been appointed by the Trustees to succeed Mr. Thompson in the chief engineership. He has been assistant engineer for just over a year, prior to which he was engineer to the Greenock Harbour Trust.

The appointment of a new general manager has been deferred.

Enlargement of Danish Harbour.

According to a wireless broadcast from Kalundborg in Danish for Denmark on July 21st the work of enlarging the harbour at Elsinore will begin in October and will take three years to complete. The cost of the development is estimated at 3,300,000 kroner.

Wartime Vermin Problems in Dockside Warehouses

Modern Methods of Checking Food Losses from Insects

By ERIC HARDY, F.Z.S.

Far too much food is destroyed or contaminated by vermin in normal times and now that dockland warehouses have to hold such valuable stores it is essential that losses from insect pests, moulds or fungi and rats should be reduced to a minimum by modern methods instead of the often futile and antiquated methods of peace-time. There are three plans of attack against the vermin of dockland warehouses: (1) local extermination of a grain mill's moths and weevils, a tobacco warehouse's moths, etc., by temperature control, fumigation with chloropicrin and H.C.N., using poison baits, etc.; (2) general control of vermin in an entire port by compulsory measures for all incoming ships and the dock estate, like the compulsory fumigation of ships at Liverpool, which reduced the average number of black rats per ship from 58.83 in 1923 to the low level of 2.02; and (3) the prevention of re-infestation by a rigid control of temperature, ventilation and humidity conditions in warehouses, removing surplus available food, rat-proofing ships and buildings, suppression of breeding haunts and immediate isolation and treatment of outbreaks, particularly of new pests (like the cacao moth which turned to a tobacco diet in the last war) to avoid re-infestion. Even if the local harbour authority does not employ an entomologist and nobody with any more biological experience than the ordinary rat catchers, its book shelf in these anxious times should have some up-to-date reference books on vermin control, like Hayhurst's "Insect Pests in Stored Products," Wardle's "Applied Zoology," Blake's "Protection of Buildings Against Vermin," Dewberry's "Prevention and Destruction of Rats," Hinton's "Rats and Mice," U.S. Public Health Service's "Rat Proofing of Buildings," and that old Liverpool classic, Melville Davison's "Ships' Hygiene."

Weevils have been the most destructive insect pests on Merseyside, but most insect pests in foodstuffs can often be treated by modern temperature control of the building when a chemical fumigant would affect the foodstuffs stored there. Most of the insects infesting flour mills, including the Mediterranean flour moth which has been established on Merseyside for some years and weaves its silken galleries as its caterpillar feeds through the starchy food, the Indian meal moth (*Plodia*) and the meal snout moth (*Pyrales*), can be destroyed by maintaining a temperature of 118-125 degrees F. for several hours. Mites in a warehouse can be destroyed by 150 degrees F. for one hour, pea and bean weevils by 146 degrees for 15 minutes, and most other weevils by 122 degrees F. Where a foodstuff infested by weevils, like rice, is liable to suffer by high temperature (e.g., the rice cracks and cannot be milled easily) then a low temperature control may be used; or if it is not possible to raise the necessary temperature for heat sterilization, a slightly lower temperature for a longer period than that recommended may be adopted. Steam pipe radiation, allowing one square foot of radiating surface for 50 to 100 cubic feet of space at a steam pressure of 25 to 50 lbs. is the usual method, heating the warehouse slightly above the advised temperature to allow for dispersal.

The important point is that the necessary temperature varies with different insect pests, and sometimes between egg and adult, and when the warehouse has been treated, there is also a much lower temperature which does not destroy the pest but reduces its activity to dormancy and thus is useful as a control against further infestation. For instance, of two common grain weevils, *Sitophilus granarius* becomes dormant at 1.6 degrees C. and dies after 38 days at such a temperature; but *S. oryzae* becomes dormant at 7.25 degrees C. and dies after 17 days dormancy; and for both dormancy is much more fatal in damp than dry grain. Storing goods at 64 degrees F. protects them against pea and bean weevil damage and at 40 degrees F. against clothes moths. Cockroaches are destroyed by 130 degrees F., bacon, larder or carpet beetles by 140 degrees, but tobacco moth is best treated with low temperature—3 or 4 degrees below zero C.— for heat darkens the tobacco and makes it brittle. All cereal insect pests can be destroyed by an hour or two at 122 to 131 degrees F., whereas the old method of fumigating with hydrocyanic acid gas, however successful with rats, is not a guarantee against flour moths and grain beetles.

Where it is possible to have the pests identified, it is an enormous help in treatment, and in this respect I might point out that the Ministry of Food has a scientific adviser at Norfolk House Hotel, Colwyn Bay, North Wales, while Dr. F. P. Coyne is honorary secretary of the Food Control Servicing and Supply Group (a membership of the Standing Conference on Infestation of Produce, Department of Scientific and Industrial Research), c/o I.C.I., Ltd., Cunard Building, Liverpool, 3, and Mr. E. A. Marshall is secretary of the Cereals and Feeding Stuffs Infestation Committee at the Imperial Hotel, Colwyn Bay. The difficulty is that wheat flour alone has 31 insect pests; 49 insect pests have been found on the walls of warehouses and one mite alone, *Tyroglyphus farinae*, has been found attacking 147 products, and a small beetle, *Ptinus testus*, 116. Most of the insect pests in stored foods—71 of them—are beetles, and the fewest are flies, of which there are only two warehouse pests.

There is no need to waste time discussing rats when the Ministry of Agriculture leaflet may be obtained free, but I would like to point out that rat-proofing a building is generally a protection against ground ventilator or drainpipe infestation by the common brown sewer or inland rat, whereas "rat proof" dockland warehouses and quay sides are often entered by the climbing black or ship rat which is an Asiatic tree-rat. Ship rats form a high proportion of dockside rats. A census of trapped rats in Liverpool showed that in city warehouses and sewers the ground haunting brown rats exceeded the tree-climbing black or ship rats in the proporion of 9 to 1; on the dock quays their numbers were about equal and on ships, black rats exceeded brown in the proportion of 139 to 1. The black ship rat has been increasing its proportion in some centres like London, Cardiff, Scarborough, etc., in recent years.

In dealing with certain insect pests like cockroaches I am much in favour of the large scale use of cheap and simply made food traps when high temperature or fumigation are impossible. In this instance a glass jam jar baited with vegetable, banana or orange peel, meat, bread, etc., flavoured with aniseed and beer can be set at night, carrying a short, inverted cone entrance of stiff smooth paper with a wide enough space for the passage of the insect's body, and some access to the top for the cockroaches attracted by the aniseed odour. They slip down the cone when inspecting the entrance and cannot escape up the slippery glass sides. As many such traps as possible are set at night and collected in the morning, the captives being tipped into boiling water to kill them. 8,430 cockroaches were caught with twelve such traps in a London warehouse in less than three months.

Ventilation is an important problem in the control of both insect pests and mould damage, because both these troubles thrive with high temperature and humidity and ventilation lowers both these dangers. Of course cold refrigeration and "gas refrigeration" are ideal methods of food storage, but they are not always possible nowadays.

The importance of watchful biological control, now that so many new foodstuffs are brought into fresh storing places and possibly mixed foreign cargoes placed together, is well known to all entomologists who have knowledge of the omnivorous diet of most insect pests which can quickly change from a harmless diet to a costly one and can be distributed all over the country from one overlooked centre at a port. The moth *Auximobasis normalis* was first discovered in Britain in a Liverpool warehouse in 1921. In 1922 *Corcyra cephalonica* did great damage to ground nuts stored there. The Angoumois grain moth (*Sitotroga cerealella*) and a relative of the domestic clothes moths, *Tinea granella*, also caused serious damage to grain stored on Merseyside, so that the importance of insect pest control is not exaggerated in these times.

Obituary

Circumstances have precluded an earlier reference to the death of **Mr. William Brodie, M.Inst.C.E.,** which took place on March 17th last at Portadown, Northern Ireland. Mr. Brodie had attained the advanced age of 87 and had been living in retirement since his superannuation in 1921.

He was born at Scone in Scotland and educated in Ireland. Entering the service of the Mersey Docks and Harbour Board in 1870, as an apprentice in the drawing office of the Engineer-in-Chief's Department, he rose to become principal assistant engineer. During his long and valuable service with the Board he was prominently identified with various enterprises for the development and improvement of the dock estate, and he took an active part in a number of important law cases. His outstanding technical and commercial ability and his zeal in the performance of his official duties were publicly recognised on his retirement by the chairman of the Board, who paid a high tribute to his long and distinguished service.

The Port of London Authority has sustained the loss of one of its members in the death, at the age of 75, of **Admiral Sir Frederick Learmouth, K.B.E., C.B.,** who, in addition to his service on the Authority as the official representative since 1925 of the Admiralty, was Hydrographer to the Navy from 1919 to 1924. Also from 1930 to 1933, he was acting Conservator of the River Mersey and he had also presided over various technical committees.

Another port official of a past generation has passed away in the person of **Mr. Alexander Hood, J.P.,** who, prior to his retirement in 1929, had spent 53 years in the service of the Leith Docks Commission. He had held the position of Treasurer and Collector of Rates.

The Boom Defence of Ports

Wartime Measures of the Past

By FRANK C. BOWEN.

Instances in Antiquity

The defence of ports and harbours by means of chains or booms is one of the most ancient devices of naval warfare, although it has latterly changed in detail to meet the submarine as well as the surface menace. Mention is made of the chains which were in use at Rhodes in the earliest times and at Constantinople (Byzantium) as early at 700 B.C. In the Middle Ages many important harbours were so protected, while La Rochelle used scuttled ships as a modified form of boom in 1371 and in 1420 Bonifacio, Corsica, was defended by a bridge of planks supported by five ships.

In Elizabethan Times

At the time of the Spanish Armada Genibelli, the Italian expert on fortifications, was commissioned to defend the Thames by a bridge of boats at Tilbury similar to the one which had been used at the Spanish Siege of Antwerp. Unfortunately it was not ordered until the last moment. It consisted mostly of Thames barges, with a few armed ships, secured with chains and ropes and protected on the seaward side with all the spare masts and spars which could be procured. A movable section in the middle permitted traffic. At about the same time Sir John Hawkyns designed an immense chain to be drawn across the Medway at Upnor Castle. This was repaired in 1606 and in 1623 was replaced by a boom consisting of the hulls of two ships and two pinnaces with spare masts, cordage and iron bars between them. A new boom was placed in position about 1635, but this again was replaced by the famous Chatham Chain, supported in the middle by hulks and kept taut by a large crane which was, unfortunately, not properly installed when the Dutch invaded the Medway in 1667. A number of ships were hurriedly sunk below Gillingham and the chain was stretched as well as possible, but the Dutch broke or rode over it without difficulty. When the Jacobites were besieging Londonderry in 1689 they blocked the river below the town with an elaborate boom which for some time was regarded as impregnable; when the merchant ships with supplies for the town broke it with comparatively little difficulty the seige was immediately raised. During the eighteenth century temporary booms are constantly mentioned as being placed across the entrance of important harbours whenever there was fear of an invasion, but most of them seem to have been extemporised, at great cost with the material available at the moment.

The Napoleonic Era

No noteworthy boom defences were arranged in Britain during the Napoleonic invasion scare, but when the Navy used an early form of mine against the French invasion fleet at Boulogne that port was protected with a very elaborate arrangement of booms and chain cables. In 1808 Basque Roads were protected by a particularly fine boom of cables which was successful in stopping the British fire ships.

In the middle of the nineteenth century, when the Royal Navy was drastically cut down for the sake of economy, there were numerous invasion scares which directed the attention of the authorities to boom defence once again. Experiments were carried out at Portsmouth in 1849 when a very elaborate one was constructed of masts, spars and chains and a sham attack on this was made by the bigger pulling boats of the fleet which naturally proved nothing. Their plan was to drive the defenders off the boom with their boat guns and howitzers and then blow up the obstruction with charges of explosive. In 1877 Scott Russell put forward a detailed plan of boom defence slung between armed rafts and reinforced by gunboats similar to those built for the Crimean campaign. The development of the torpedo boat at about that time greatly added to the interest of the subject and the Admiralty paid far more attention to it.

In Modern Warfare

In the famous Fleet exercises of 1885 the entrances to Berehaven were closed with double booms formed of all the spars of the ships of the defending squadron, protected on the outside by mines, and the opportunity was taken to give it a thorough test. First a steam launch, nearly as big as many of the torpedo boats of that day, was set to it and jumped it without the least difficulty. Then the ram *Polyphemus*, the famous freak whose design was not repeated in the Navy, charged it at 17 knots and cut right through it without the least difficulty or even feeling a shock.

It was a great disappointment, but the rapid development of the torpedo boat kept the subject to the front and plans were made to fit all the principal naval ports with continuous boom defence placed outside the anchorages. A trial section was made of strong baulks of timber, plentifully studded with heavy steel spikes, and this was moored in Portsmouth Harbour. A first-class torpedo boat under the command of Lieutenant Doveton Sturdee, later to be the victor of the Falklands, was ordered to test its strength by ramming it at full speed. She had not the least difficulty in cutting through it, so that an improvement was made on what was called the ladder principle, composed of baulks of timber placed transversely across four wired hawsers, reinforced by spars and armed with steel spikes. Four feet above the baulks was stretched a 6-in. wire hawser intended to sweep the decks of any vessel trying to jump it, and in 1890 Sturdee's torpedo boat, No. 76, was again brought forward to test it. She was fitted from stem to stern with a stout wooden horse, or strong back, the predecessor of the jumping wires fitted in all modern submarines. This carried the hawser over her quite effectively, but the spikes stopped her and she foundered in getting clear. The Admiralty then adopted the type, but many naval officers were not satisfied and the future Admiral R. H. S. Bacon tested it with a torpedo boat prepared with many of the same fittings as the 76, with improvements. The principal improvement was the use of " T " iron with edges sharpened to reinforce the wooden strongback, and with this Bacon passed quite safely over the baulks and through the hawsers. He records how the Admiralty was annoyed at the way the boom had been cut through and ordered him to remove the " T " irons; when this was done the boat failed to get through and the Admiralty was satisfied. In 1908 the Destroyer *Ferret* proved at Portsmouth that booms could still be jumped and more attention was paid to the subject.

The inevitability of war with Germany caused a Booms Committee to be set up to consider the matter. There was a flood of suggestions from the public and a number of experiments were carried out at Southampton which produced little result. Commander Munro, one of the members of the Committee, happened to notice the powerful towing engine fitted in the Anglo-American tanker *Iroquois* for towing the barge *Navahoe* across the Atlantic and suggested that this gear should be adapted for boom work, giving sufficient spring at either end to pull up the attacking ship without being cut. The Destroyer *Ranger* tested this idea and it proved excellent; the engine paid out enough wire to bring her up and then hove in against her strongest thrust. Unfortunately the war broke out before the Committee had completed its work and it had only considered attack by surface vessels.

The trend of events at the beginning of the war in 1914, and the possibilities of the German submarine fleet, immediately increased the importance of boom defence. Dummy booms, impressing " neutral " observers by intricate navigation where, as a matter of fact, there had been no opportunity to place obstructions, could only serve for a time. A number of blockships were sunk at the entrances to Scapa Flow, Dover, Portland and other ports to restrict attack while the production of effective booms went on as rapidly as possible. Some of these blockships were very effective, either by themselves or by the addition of strong superstructures, while others were swept away almost immediately. The comforting belief that the anchorage at Scapa Flow was protected from submarines by the nature of its channels was soon dispelled and arrangements had to be made for the fitting of a boom. In the meantime the Grand Fleet was homeless, and lost the *Audacious* by mine while off the North Coast of Ireland.

At Cromarty a boom was very rapidly built, including anti-submarine nets which extended to the bottom, suspended between trawlers and held up on their winches. This completely closed the Firth to submarines and destroyers and the rapidity with which it was installed, being completed before the end of October, 1914, was a fine tribute to individual enterprise. It was for this that Commander D. J. Munro was placed in charge of all boom work by the Admiralty. He had to surmount many difficulties, particularly in the matter of supplies, but by the summer of 1915 every entrance to Scapa Flow was protected by an effective boom and a second line was then put up. Other bases were also equipped and finally there was the gigantic work of throwing a boom right across the Straits of Dover. This consisted very largely of nets, but it proved impossible to maintain it in its original form.

Boom defence was one of the things in which the Admiralty maintained a keen interest after the war and on which it carried out a number of experiments while the money was available. Then there had to be an interval, but in the early 'thirties they were resumed and a number of trawlers were bought and converted into boom defence vessels. Under later estimates special tonnage was built, the net-layers *Guardian* and *Protector* and special boom defence vessels, self-propelling and armed against attack, with the most elaborate deck machinery for handling the obstructions. What is being done with these vessels now is naturally a confidential matter, but it may be taken for granted that the careful experiments carried out by the Admiralty have not been wasted and that the ancient science of boom defence, adapted to modern needs, is now very efficient indeed.